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Radiation Necrosis of the Calvarium: Report of Five Cases[1]

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THIS STUDY represents a review of 2,046 cases of intracranial tumors which were treated by roentgen rays, either with or without surgical measures. In this series only 5 cases of aseptic necrosis of the calvarium were found, but since in most instances no follow-up roentgenograms were available, this figure should not be considered a true gauge of the incidence of this condition.

Since a review of the literature has failed to reveal any report of similar changes in the calvarium after roentgen treatment of intracranial tumor, a presentation of the pertinent data seems justifiable.

The fact that irradiation affects bone tissue has been well known for a number of years. Ewing (1, 2) discussed radiation osteitis at length and also pointed out that, contrary to the general concept, bone is but slightly more opaque than most soft tissue and only to soft rays. Calcium, which has an atomic weight of 40, must be very closely compacted in hard bone to make the latter much more opaque than muscle, skin, or tendon.

Regaud (3), in 1922, first called attention to the great susceptibility of the jaws to necrosis and concluded that bone is more prone to react to radiation than is skin. Later, Watson and Scarborough (4), investigating the effects of heavy external irradiation of bone, found that the periosteum is apparently very radiosensitive.

Strauss and McGoldrick (5) declared that statements to the effect that adult bone is resistant to radiation are purely relative and should not be interpreted as implying complete immunity to radiation effects. They stated that, if enough radiation is administered, the vascular, periosteal, and osseous changes will inevitably result in serious complications. These writers reported instances of fracture of the femoral neck after roentgen therapy. The involved bone had not been invaded by secondary infection, and the effects were attributed to irradiation.

Ewing pointed out that the blood vascular system of bone renders this tissue particularly susceptible to strangulation from occlusion of the haversian canals. This

[1] Read in part at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

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susceptibility is probably due primarily to the action of secondary rays on the delicate cellular processes in the canaliculi; secondarily, to physical changes in the composition of the bone laminae, which become very brittle. The long delay in sequestration and resistance of the tissue to solution are probably the results of injury and sclerosis of blood and lymph vessels in the haversian system, periosteum, and surrounding tissues.

Nageotte (6) postulated that the bone cells are probably more susceptible than the bone lamellae and concluded that the cells are readily killed by irradiation, causing the osseous substance to go through devitalization and alteration.

Secondary radiation from bone tissue is difficult to estimate and both secondary and scattered rays increase in direct proportion to hardness of the irradiated tissue. Large amounts of calcium in bone tissue would tend to increase the secondary and scattering effects. In view of the delicate nature of the cytoplasmic processes connecting bone cells through the fine canalicular system, on which activity of the matrix of the bone is dependent for nutrition, the danger of injury to the bone by direct and secondary radiation is apparent.

The calvarium is composed of three layers of bone, a compact layer on each side of a spongy layer. It is supplied by end arterioles from the periosteum. Because both secondary and scattered rays increase in proportion to the hardness of the tissue or amount of calcium present, the structure of the calvarium is well suited for the development of radiation necrosis.

Although Stewart (7) points out that the calvarium includes the bones of the head which are altered least frequently by irradiation, one wonders whether the fact that the calvarium does not function as a weight-bearing structure, and therefore presents no symptoms due to the necrosis, has not contributed to erroneous diagnoses and resulted in failure to establish the true incidence.

Aseptic necrosis of the calvarium must be differentiated from multiple myeloma and metastatic carcinoma. A previously negative examination of the skull, followed by evidences of punched-out portions limited to regions which have been treated, and absence of any signs of this condition elsewhere in the skeleton, plus biopsy whenever possible, provide the differentiation.

In many instances of necrosis of the calvarium, the changes were interpreted by the original observers as evidence of metastatic cancer. Possibly other cases may have masqueraded under the same diagnosis, since the factors utilized in treatment were not different from those used in cases of similar nature at that time.

None of our five patients had symptoms referable to the necrosis. Since the calvarium is not a weight-bearing structure, the condition is not as dangerous as necrosis in the hip. Considering the length of time these patients survived after treatment and the fact that in several instances irradiation was the only therapy offered, it does not seem necessary to sacrifice radiation dosage because of the possibility of an aseptic necrosis in the calvarium.

REPORT OF CASES

CASE I: A white woman, 43 years of age, was admitted to the Mayo Clinic on Oct. 12, 1925. The family and past histories were not significant. The present illness began two years previously, when the patient first noticed that she could not read her watch clearly. The visual disturbance disappeared, and in July 1924 she was free from symptoms for two or three weeks. After this, the difficulty reappeared, having been aggravated by excessive reading. Nervousness, momentary dizziness, and occasional nausea were accompanying symptoms. A physician was consulted in May 1925, and the patient was given glasses but received no relief. During the two months before coming to the Clinic she had not been able to recognize people or to read.

The results of general physical and special neurologic examinations were essentially negative, with the exception that examination of the eyes suggested a chiasmal lesion. There was questionable weakness of the right hand and arm, with slightly exaggerated reflexes. No sensory changes could be made out.

Exploration through an Adson pituitary approach and a decompression were performed on Dec. 1, 1925, and a tumor situated above the sella turcica was found. Its reddish-blue color and granular appearance suggested that it arose from the

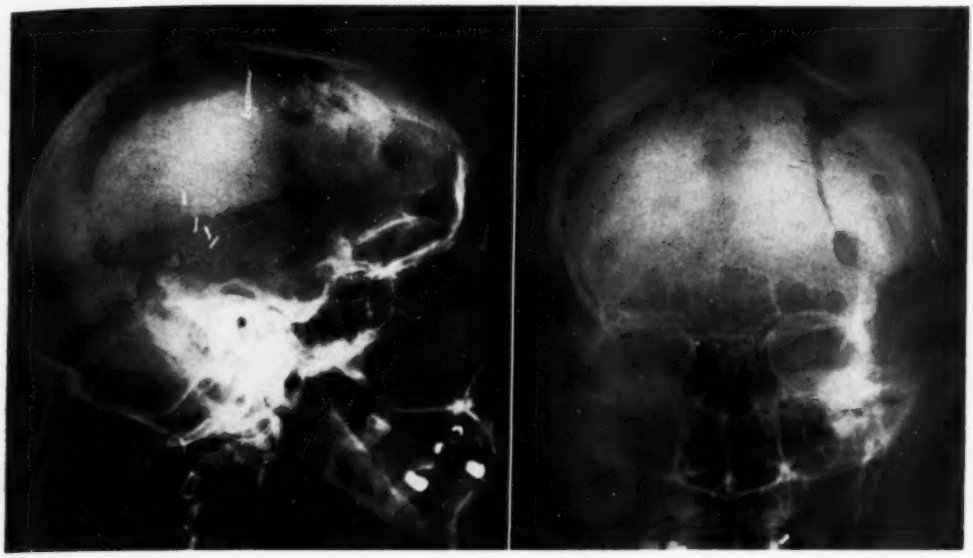

Fig. 1. Case I: Roentgenograms made approximately five years after original roentgen therapy was administered, showing multiple punched-out areas in the calvarium. (Courtesy Dr. F. E. Templeton, Chicago, Ill.)

sphenoid sinus. In view of the vascularity of the neoplasm, its sessile character, and extent, complete removal was impossible. For this reason the tumor was not touched, even to the extent of obtaining a specimen for biopsy.

Postoperative roentgen therapy was administered, the calvarium being divided into four fields, two on each side. From Dec. 15 to 21, a total of 550 to 600 r, measured in air, was delivered to each field. The technical factors were 200 kv. (peak), 5 ma., 1.0 mm. copper and 1.0 mm. aluminum filtration, 50 cm. distance, and 1 hour and 50 minutes time.

Between March 10, 1926, and Sept. 27, 1929, the patient received elsewhere an additional 10,400 r to the calvarium, 5,175 r to the left side, 4,375 r to the right side, and 850 r to the back (posterior). The technical factors used to administer this dosage were 200 kv., 5 ma., 0.75 mm. copper and 1.0 mm. aluminum filters, 20 cm. distance, and 40 minutes time. Occasionally the kilovoltage was cut to 150 and the time to 30 minutes; but the dosage, filter, and distance remained the same.

We were informed by letter that roentgenograms of the skull, made on or about April 16, 1930, revealed multiple punched-out regions and, because of this, a search was being made for a primary tumor. Later, however, when a "button of bone" was removed, the histologic picture was not that of metastatic tumor but of fibrous osteitis.

Comment: This is undoubtedly an example of radiation osteitis of the calvarium, discovered approximately five years after the original roentgen therapy was administered (Fig. 1).

CASE II: A white man, 38 years of age, was admitted to the Clinic on Aug. 30, 1926, complaining of weakness in the right arm and right leg. The family and past histories were not significant. The present illness began in May 1925, when the patient had about five spells of jerking of the right arm and hand. These spells, which came at intervals of two days, lasted about two minutes. There was residual weakness for five or six hours after each attack. Ten weeks later weakness was noticed in the right hand and the patient experienced difficulty holding a paint brush. He also found that his hand was not as steady as formerly, especially when he tried to use a fine brush while painting signs. About the same time he noticed weakness in the right leg and footdrop, especially when ascending stairs or climbing a ladder. This weakness progressed gradually. Recently he had experienced difficulty in expressing his thoughts in words.

The results of general examination were negative except for the neurologic findings. Right facial weakness and weakness and atrophy of the right half of the tongue were revealed. The lingual weakness and atrophy were graded 2 on the basis of 1 to 4, in which 1 represents the least and 4 the greatest degree. There was also weakness of the arm and leg on the right side. Roentgenograms of the skull were negative except for an osteoma in the frontoparietal region. The results of laboratory examinations were negative.

Fig. 2. Case II: Roentgenograms showing numerous small, rounded regions of rarefaction, originally thought to be vascular anomalies.

Exploration and decompression over the left frontoparietal region were performed. A large osteoma over the left frontoparietal region indicated the probability of an endothelioma or meningioma. The line of incision included the osteoma and an osteoplastic flap was turned down. The dura was very vascular; on opening it, the convolutions were found to be greatly thickened and flattened. Palpation revealed some fluctuation. On insertion of trocar and cannula, 1.5 c.c. of yellow fluid was aspirated. This clouded on standing. The osteomatous region was removed during decompression. The pathologists reported that nothing of an inflammatory or malignant nature was found.

Roentgen therapy was given from Sept. 24 to 28, 1926, the calvarium being divided into four fields, each of which received 550 r. The technical factors were 200 kv., 5 ma., 0.75 mm. copper and 1.0 mm. aluminum filtration, 50 cm. distance, 1 hour and 20 minutes time. This treatment was repeated between Feb. 10 and 14, 1927.

Nothing further was heard from the patient until June 11, 1937, when he returned to the Clinic complaining of convulsions. He had no headaches which were of significance. The diagnosis was jacksonian epilepsy, adenomatous goiter, and anemia. On June 22, subtotal thyroidectomy was performed.

Roentgenograms of the skull on June 11 revealed the bone flap and hemostatic clips of the previous operation and also numerous small rounded regions of rarefaction in the bone flap and other portions of the calvarium. At this time these regions were thought to be vascular anomalies (Fig. 2). On later review of this case, however, it seemed that the only explanation was on the basis of radiation necrosis, since no such anomalies appeared in the original roentgenograms. Also, there was no history of any trouble referable to a distinct pathologic lesion of such magnitude. Follow-up showed that the patient was well and working on May 15, 1942.

Comment: **In this case radiation necrosis was found approximately eleven years after administration of the initial dose of roentgen therapy. It had caused no symptoms whatever.**

CASE III: A white man, 42 years of age, was admitted to the Clinic on Oct. 18, 1927, complaining of headaches. The past and family histories were not significant, except for the occurrence of headaches of the migraine type since July 1922. The present illness began in the summer of 1926, with headaches in the occipital region, radiating down the muscles of the neck. The pain was sharp and periodic, recurring several times during the day. In January 1927, a diplopia developed suddenly and this, as well as the other symptoms, progressed.

The results of physical examination were essentially negative except for the eyes, which showed choked disk, 4 diopters, and bilateral weakness of the external rectus muscle, especially on the right. There were no localized signs. Roentgenograms of the skull were negative.

On Oct. 26, 1927, exploration and decompression were performed. A large osteoplastic flap was turned down over the right temporoparieto-occipital region. The dura was under increased tension. The exploring trocar in the occipital lobe came in contact with an extensive fibrous mass about 3 cm. below the cortex. A large decompression, measuring 4 or 5 cm., was made at the base of the flap.

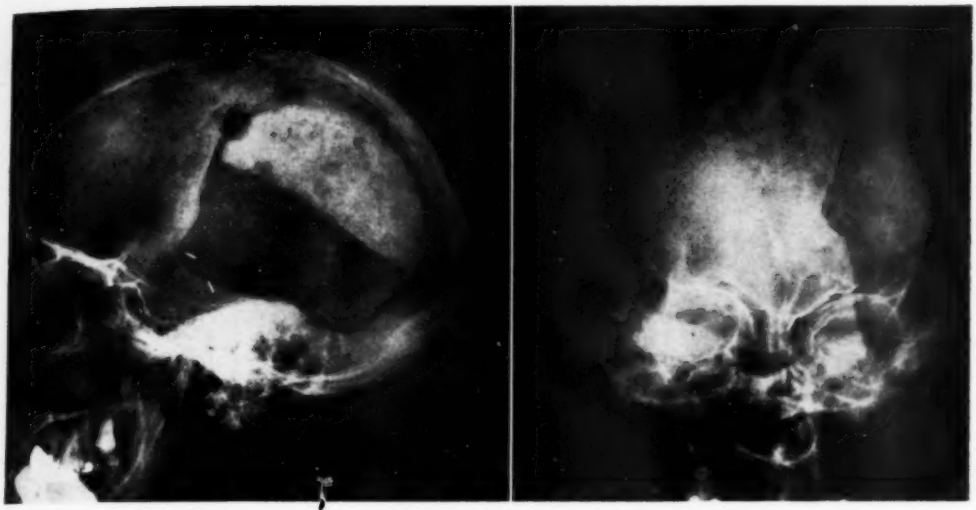

Fig. 3. Case III: Roentgenograms showing changes secondary to irradiation, approximately fourteen years after treatment.

Between Nov. 9 and 12, 1927, roentgen therapy was given, the calvarium being divided into four fields, two on each side. A dose of 500 to 520 r was delivered to each of these fields. The technical factors were 200 kv., 5 ma., 0.75 mm. copper and 1.0 mm. aluminum filtration, 50 cm. distance, and 1 hour and 10 minutes time. This treatment was repeated in February and in April of 1928, one field being irradiated each day.

On March 19, 1930, tapping of a postoperative cyst was performed.

Follow-up roentgenograms of the skull were made from time to time, the first to show any change being those of Sept. 28, 1939. In addition to the evidence of previous craniotomy and metal clips, there was increased density of the bone flap and generalized osteoporosis of the calvarium. Roentgenograms made on April 22, 1942, in addition to these findings, disclosed mottling of the entire calvarium with regions of rarefaction and some increased density of bone. These changes were considered to represent aseptic radiation necrosis secondary to roentgen therapy (Fig. 3). The patient had no signs or symptoms referable to the condition in the calvarium and was apparently getting along well.

Comment: In this case the first evidence of radiation necrosis was revealed by roentgenograms about twelve years after the initial x-ray treatment.

CASE IV: A white woman, 50 years of age, was admitted to the Clinic on April 12, 1938, complaining of failing vision for the previous eleven months. The family history was not significant. In 1924, the patient had experienced visual difficulties for three months before undergoing an operation for a pituitary tumor. She received postoperative roentgen therapy. Five days after operation, there was complete return of vision in the left eye but only partial return in the right eye. The patient's general health had been good until eight or nine months prior to admission, when some memory changes developed, which recently had become more pronounced. She had difficulty remembering names and would forget to do things which she had intended to do.

Roentgenograms of the skull on April 14, 1938, revealed multiple regions of destruction on each side of the calvarium in the frontal, temporal, and parietal portions. Extensive destruction and changes in the sella turcica indicated an actively growing tumor (Fig. 4).

Right transfrontal craniotomy with extradural intracapsular enucleation of the tumor (Adson technic) was performed on April 16, 1938. The tumor, which presented a smooth capsule containing typical pulpy, reddish, granular material, was removed by blunt dissection, with the aid of a bayonet which had a cotton ball on the end, a gallbladder scoop, and a pituitary forceps. Thorough dissection was performed.

Death occurred on April 19, 1938, from bronchopneumonia. No evidence of metastasis was found at necropsy.

On inquiry into the amount of roentgen therapy this patient had received prior to coming to the Clinic, we found that 600 r had been administered to each temporal field in April and in May 1924. The following technical factors were used: 9 inch gap, 6 ma., 0.25 mm. copper filter, 12 inch distance, 25 minutes time. An additional 360 r to each of these fields had been given in June, July, and August

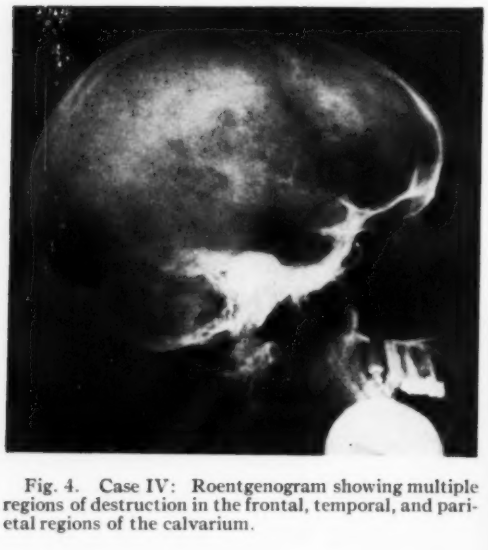

Fig. 4. Case IV: Roentgenogram showing multiple regions of destruction in the frontal, temporal, and parietal regions of the calvarium.

of the same year. The technical factors used for the latter treatment were 135 kv., 5 ma., and 6.0 mm. aluminum filter; the distance and time varied. The patient also received 320 r to each temporal field in March and 380 r in May 1925, the technical factors being similar to those used in the preceding June, July, and August.

After microscopic examination of a section of involved bone removed at operation, the pathologists reported that the lacunae were distinct but uniformly devoid of osteocytes. The osseous lamellae showed numerous tiny, closely grouped oval spaces presenting a moth-eaten appearance. In these regions the osseous matrix had a slightly fibrillar appearance. The pathologists concluded that the absence of osteocytes and cellular outlines, as well as the changes in the osseous matrix, warranted the conclusion of aseptic necrosis of bone.

Comment: This patient, who was treated over a period of thirteen months, received a total of 2,980 r to the right and left temporal regions. Fourteen years later roentgenograms showed evidence of multiple areas of destruction only where roentgen treatment had been applied. Undoubtedly this could be due only to the irradiation.

CASE V: A white woman, 58 years of age, was admitted to the Clinic on Oct. 10, 1941, complaining of headaches. The family history was not significant. The headaches had begun in 1924, at which time a diagnosis of pituitary tumor had been made and roentgen treatment had been advised. In 1931, the patient had a cerebral hemorrhage but recovered after treatment. Her present illness, which was characterized by headaches occurring at first two or three times a week and later daily, began six weeks before admission. The headaches, which were dull in type, generally were located in the front and top part of the head. They were worse at night and disappeared soon after the patient rose in the morning. She had been referred to a neurologist, and roentgenographic examination of the head at that time had shown multiple regions of metastasis. She had received four roentgen treatments a week before admission.

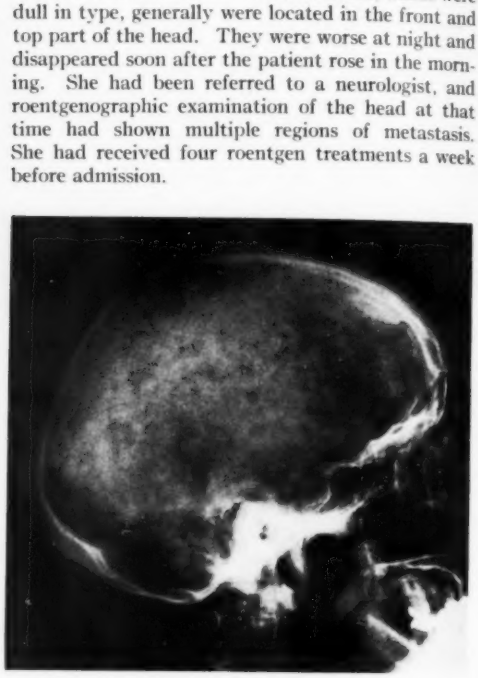

Fig. 5. Case V: Roentgenogram showing bilateral, somewhat symmetrical regions of destruction in the calvarium which coincide with fields treated previously by irradiation.

The results of physical examination were essentially negative, except for areas of alopecia and slight atrophy of the skin on the scalp where treatment had been administered. Roentgenograms of the skull revealed multiple regions of destruction in the cranial bones; these were bilateral and rather symmetrical in distribution. In view of the history of roentgen treatment, these changes were considered the result of circulatory changes in the bone, representing aseptic necrosis rather than metastatic cancer (Fig. 5).

On inquiry, the following information about previous roentgen treatments was obtained. In March 1924, 400 r had been administered to each of two temporal fields. The technical factors were 9 inch gap, 6 ma., 0.25 mm. copper filter, 12 inch distance, 25 minutes time. Also, in May, June, and August of the same year the patient had received at another place, 500 r to each of these fields, the technical factors being 140 kv., 0.5 mm. copper and 1.0 mm. aluminum filtration, 10 cm. portal, 12 inch distance and 40 minutes time. Treatments just prior to coming to the clinic consisted of 600 r administered to each field. The technical factors were 200 kv.,

15 ma., 0.5 mm. copper, and 1.0 mm. aluminum filtration, 50 cm. distance, 13 minutes time.

Comment: This is another example of a pituitary tumor which was treated by fairly heavy irradiation over each parietal region. Seventeen years after the original treatment, the skull showed evidence of aseptic necrosis limited to those regions which had been irradiated. The necrosis was undoubtedly attributable to irradiation. We do not believe that the treatments administered just before admission to the clinic played any part in the process but we have included the factors to complete the report. Since this patient had had no pain in the region of the bone lesions, estimation of their duration was impossible and the finding was apparently unexpected. Since such a lesion is asymptomatic, its presence becomes known only when medical attention is sought for other reasons or on a check-up.

SUMMARY AND CONCLUSIONS

Five cases of radiation necrosis of the calvarium are reported and the condition is reviewed briefly from the pathologic standpoint. The process is an aseptic necrosis due to strangulation of the blood supply. Diagnosis is best proved by biopsy.

Since none of these five patients had presented symptoms referable to the condition, and since the calvarium does not function as a structure of stress, we do not feel that large doses of radiation should be withheld from the patient because of the possibility of changes in the calvarium, especially in view of the number of years these patients had survived since treatment was administered.

In our opinion, a further review of cases of intracranial tumors treated by roentgen therapy would reveal a higher incidence of radiation necrosis of the calvarium than we have noted. Many cases which have a similar roentgenographic appearance may possibly be filed under other diagnoses.

Any patient with changes such as those described in these cases, who has received fairly large doses of roentgen therapy to the calvarium, should be suspected of having an aseptic radiation necrosis.

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Arachnodactyly[1]

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IN 1896, MARFAN first described the unusual syndrome now known as arachnodactyly when he reported the case of a child who exhibited extreme length and slenderness of the bones of the hands and feet. Marfan also called attention to the coexistence of other abnormalities. He considered the condition to be congenital or familial in origin and suggested for it the name of dolichostenomelia. Although this syndrome has been reported with considerable regularity by French and German physicians, arachnodactyly was not described in the American literature until 1926, when Piper and Irvine-Jones discussed the pathologic aspects of their case and stressed the frequency of the congenital cardiac abnormalities associated with this disease.

During the past year we have seen four patients with arachnodactyly, three of whom are in the same family, a father and two daughters. It is our purpose to outline briefly the more characteristic manifestations of this relatively rare anomaly, to mention a few of the more acceptable theories as to its etiology, and to report the essential differential diagnostic features of our cases.

It is safe to say that the diagnosis of arachnodactyly can be established in the majority of cases by a hasty survey of the patient as he enters the office, providing the physician is conscious of the essential features of this syndrome. The appearance is absolutely typical. For his age, the patient is tall and awkward looking, with excessively long arms and legs, long, thin, spider-like hands, meager subcutaneous fat, underdeveloped atonic musculature, and often ectopia lentis. The degree of emaciation present accentuates the bony landmarks, and these, in turn, serve to emphasize the disproportionate increase in the length of the extremities as compared to the trunk.

Attention is immediately focused on the delicately elongated, spider-like fingers, which are sufficiently characteristic to give this syndrome its name. The appearance of the unusually thin and tapered hand is the result of a deficiency of the surrounding soft parts and a considerable increase in length, without a corresponding increase in diameter, of the metacarpal and phalangeal bones. The relaxed and elongated ligaments, with resultant hypermotility, yet normal efficiency of the joints, permit the patient to perform all sorts of armchair gymnastics (Fig. 1). The feet and toes are likewise long and slender. Deformities of the joints are common. Pes planus, contractures, hammer toes, webbing, and sometimes abnormally mobile patellae occur. The frequently associated scoliosis, kyphosis, winged scapula, and deformities of the sternum are considered to be the result of the laxity of the ligaments and atonic musculature, with resultant inadequate support for proper posture.

The skull of the arachnodactylic patient tends to be dolichocephalic in contour, with prominent supra-orbital ridges, frontal bossing, a pointed chin, and either a prominent or broad, somewhat flattened nose. The face is usually drawn, wrinkled, and old looking, often with a melancholy expression. The ears are frequently enlarged and poorly supported because of deficient and imperfectly developed auricular cartilage.

[1] Accepted for publication in January 1945.

The eye signs, when present, are of prime importance in establishing the diagnosis. Approximately 50 per cent of the patients have this major characteristic, a partial dislocation of the lens, usually upward, generally bilateral and symmetrical. The pupils are small and react sluggishly. The convex edge of the lens can usually be seen in some part of the pupil. The movements of the eyeball disclose a tremulous condition of the lens and iris. The subluxated lens is often partially or completely opaque, which adds to the visual disturbance. Because of refractive errors and interference with accommodation, the patient usually has worn glasses since childhood, and this adds to his prematurely senescent appearance.

Congenital heart anomalies frequently accompany the disease and consist mainly of a patent foramen ovale and other interauricular septal defects. On auscultation, loud precordial systolic murmurs are the rule; more rarely, a diastolic murmur is encountered. With a history of fever and aching pain, the differential diagnosis between rheumatic heart disease and a congenital anomaly or both may become a real problem (4). The fluoroscopic and roentgenologic survey of the heart frequently will be of little diagnostic aid because of the displacement and distortion of the cardiac outline secondary to the thoracic deformity. Pneumonia is common as a result of these thoracic defects, which predispose to infection. An absent or rudimentary lobe of the lung is occasionally reported.

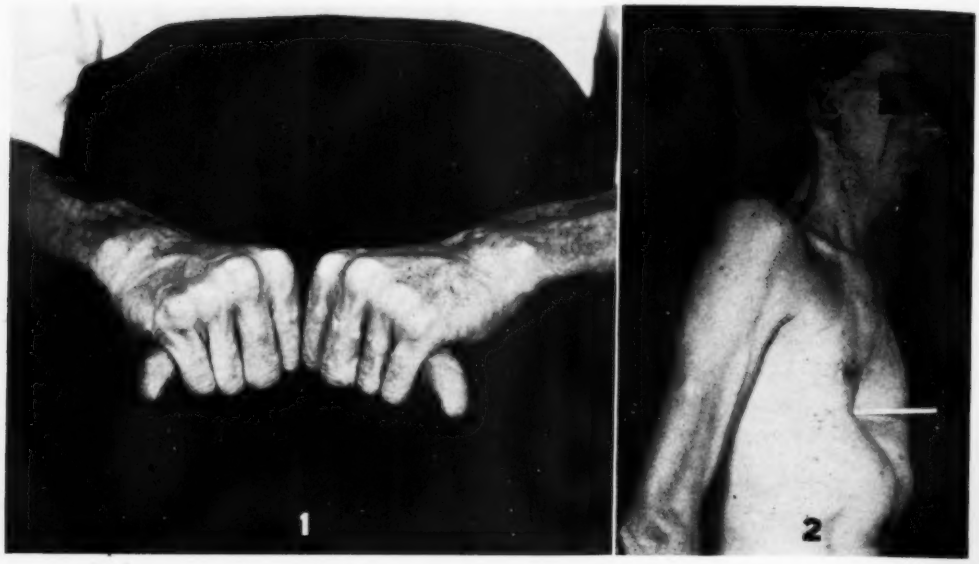
There has been much speculation as to the exact etiology of arachnodactyly. In view of the striking changes in connective-tissue structure, bones, and muscles, the present-day concept favors an hereditary and congenital embryologic derangement in the mesodermal elements of the body tissues in the early weeks of fetal life. Since the eyes are affected in approximately 50 per cent of cases and are of ectodermal origin, a defect in a certain chromosome or chromosomes seems a plausible assumption in an effort to postulate one cause for this anomaly. Burch, quoting a personal communication from Ida Mann, includes the following in his review of the subject.

> There is no evidence to lead us to suppose that mesodermal and ectodermal structures are segregated in different chromosomes and there is no apparent reason why the characters of the extremities should not be carried by the same chromosome as certain eye characters. Indeed, there is even slight evidence in favor of their being in close proximity since polydactyly and syndactyly are common concomitants of many ocular anomalies.

While considering the dystrophy mesodermal, Francois postulated the theory of fetal gigantism. A comparison of the roentgenologic measurements with the normal of the same age points to a partial gigantism, with the bones of the hands, and particularly the terminal phalanges, most affected. Of four cases in which autopsy was performed (4), three showed what was thought to be an increase in the number of eosinophils, with several small cysts in the hypophysis. This theory presumes an abnormally increased amount of pituitary secretion during intra-uterine life either from the gland of the fetus or of the mother. We have no direct evidence, however, to substantiate the presence of an increased hormonal secretion of either pituitary gland or an abnormal pituitary activity in postnatal life.

The bodily proportions of the arachnodactylic child, *i.e.*, the span being greater than the height, along with an increased height for the age, closely simulate pituitary gigantism before puberty. In the latter, however, the bone age is usually retarded, while in arachnodactyly, as seen in our cases, the bone age is increased by at least two years. While similar bodily proportions are found in the eunuchoid adult, retarded bone maturation and genital hypoplasia are prominent features not present in arachnodactyly. The possibility of an increase in growth-promoting factors of the pituitary which ceases at puberty is further made unlikely in the absence of an increase in lateral bone growth.

Clinical evidence has not supported the earlier theory of parental reproductive ex-



Figs. 1 and 2. Case I. Hypermotility of joints of hands and sternal depression, 10 cm. Note lack of subcutaneous tissue.

haustion nor do the pathologic reports substantiate hyperchondroplasia as the cause. Other authors have held the condition to be the result of a muscular dystrophy, an embryologic nutritional disturbance, or of the action of some toxin when the embryologic structures are undergoing specific differentiation *in utero*.

REPORT OF CASES

CASE I: A 37-year-old man was admitted to the Clinic on Dec. 13, 1943, for a general examination. For two years he had complained of progressive fatigue. During the past year, he had suffered from stomach trouble described as a sense of fullness after meals and occasional heartburn. Gaseous foods caused a sense of pressure in the chest, choking sensations, and eructation. The patient's parents, of Austrian descent, were of average height. Two brothers were over 6 feet tall and described as slender. Two sisters were 5 feet 6 inches and 5 feet 7 inches, respectively. During the patient's early childhood, a neighborhood physician commented on his unusually long and narrow hands and feet and made a diagnosis of rickets because of sternal depression. During adolescence, the patient recalled performing various feats of double-jointedness to the wonderment of his friends. He had always been tall, underweight, and poorly developed, but he had considered his health satisfactory. Hunting was his favorite sport in spite of impaired vision in his left eye since birth. His school work had been average. He had worn glasses constantly since the age of twelve.

Physical examination showed the patient to be poorly nourished, underdeveloped, and atonically muscled, but in no acute distress. His span was $76^1/_2$ inches, his height $72^1/_2$ inches, and his weight 148 pounds, with little or no subcutaneous fat. The skin of the face, back and shoulders was scarred from a chronic acne. The extreme depression of the body of the sternum was a striking feature; a ruler extended 10 cm. into this thoracic deformity (Fig. 2). There were pronounced flaring of the lower rib margins and a structural scoliosis of the spine.

Visual acuity and fundoscopic examination showed the right eye to be normal, but examination of the left revealed partial dislocation of an opaque lens upward and to the left, the patient being able to distinguish little more than light from dark.

The supra-orbital ridges were prominent. Examination of the mouth gave negative results except for dental caries. The normal efficiency but remarkable hypermotility of the long and spidery hands was an extraordinary feature. The patient wore a size 11 glove but stated that "these never fit because the fingers are never long enough." His feet were long and slender, with pes planus deformity and flexion contractures of the second toes.

The lungs were clear. The heart appeared enlarged because of the displacement to the left. There was a soft blowing systolic murmur in the mitral area. The blood pressure was 130 mm. systolic and 80 mm. diastolic. Abdominal examination showed nothing of significance.

A roentgenogram of the skull did not reveal any

abnormality. Fluoroscopic and roentgenographic examination showed a marked scoliosis of the dorsal spine with convexity to the left in the upper dorsal region and to the right in the lower dorsal area. The lungs were clear. Because of the scoliosis, the heart was in the left thorax. The stomach and duodenal cap were normal. There was some redundancy of the duodenal loop.

The hemoglobin was 16.5 gm. or 106 per cent. Red blood cells numbered 5,200,000, white blood cells 5,450, and the differential count was normal. Urinalysis gave negative results. The sedimentation rate was 11 mm. per hour.

CASE II: The 9-year-old daughter of the patient described as Case I was admitted to the Clinic in March 1944, complaining of inability to gain weight and easy fatigability of two years' duration. Her father stated that she had had eye trouble since birth, and a diagnosis had been made of rheumatic fever at the age of four. Since that age, her health was described as poor. Periodically she was placed at bed rest because of an unexplained fever of 102°, accompanied by weakness and fatigue. She had managed to keep up in her school work and was considered an excellent student. No history of migratory joint pain could be elicited. There were mild to moderate dyspnea and weakness on slight exertion. The patient's appetite was poor and she was given weak tea each morning to "settle her stomach."

Fig. 3. Case II. Nine-year-old girl, showing elongated arms and legs, long tapering hands and feet, sternal depression, and lack of subcutaneous tissue.

Fig. 4. Case II. Advanced epiphyseal development.

Physical examination showed the patient to be malnourished, with poor muscular development and minimal subcutaneous fat (Fig. 3). Her height was 63 inches (normal average 50½ inches by the Burgess chart), span 65 inches, and weight 74 pounds. The eyes were wide-set, with a slight exophthalmos, and the lenses were displaced. The upper incisors were protuberant, the other teeth carious. There was a palpable cervical lymphadenopathy. The palate was highly arched. The chest was funnel-shaped, with a slight flaring of the costal margins. The hands were exceptionally long and slender (Fig. 4). The child was able to perform many of the same gymnastics with her hands as her father. The long spindle-like legs and feet were striking. Pes planus

Fig. 5. Case III. Seven-year-old girl, showing elongated arms and legs and poor development of subcutaneous tissue.

was present. There was a generalized hypotonicity of all the muscles. The abdomen was moderately protuberant—one manifestation of a generalized hypotonicity. The lung fields were clear. There was a grade 2 systolic murmur in the mitral area with a snapping second sound. The blood pressure was 110 mm. systolic and 70 mm. diastolic.

A roentgenogram of the chest showed the lungs to be clear. Fluoroscopy showed the heart to be shifted toward the left and slightly rotated, the type of abnormality seen in a cavum thoracis deformity. Roentgenograms of the hands revealed long, spidery fingers (Fig. 4), with an epiphyseal age of twelve years and between five and nine months.

CASE III: A girl, aged 7 years, was admitted to the Clinic in March 1944 for a general physical examination. Like her father and sister (Cases I and II), she had "always had long slender hands and eye trouble since birth." Dentition had been late enough to cause her parents some concern. Her father stated that she had always been tall and thin and had complained of shortness of breath and fatigue when indulging in childhood games. She had had none of the usual diseases of childhood.

The patient was underdeveloped and undernourished, with poor muscle tone and only minimal subcutaneous fat (Fig. 5). The eyes were wide-set, with a slight congenital exophthalmos. Ectopia lentis was present. The frontal incisors were protuberant. Dental caries and marked dental irregularity were noted. The chest was of the pigeon-breasted type. The height was 57½ inches (normal

Fig. 6. Case III. Advanced epiphyseal development.

average 46½ inches), span 60 inches, and the weight 62 pounds. The hands and feet were abnormally long and slender.

The lungs were clear. There was a faint systolic murmur at the apex. The abdomen was somewhat protuberant, indicative of poor muscle tone and inadequate support for proper posture rather than any increase in subcutaneous fat.

Roentgenograms of the hands showed long tapering fingers, the epiphyseal age being nine years and nine months (Fig. 6). Roentgenographically the lungs appeared clear and the heart of normal configuration.

The hemoglobin was 13 gm. or 93 per cent. Red blood cells numbered 4,170,000 and white blood cells 9,800, with a normal differential count. The Hinton test gave negative results. The sedimentation rate was 15 mm. per hour. The electrocardiogram was normal except for right axis deviation.

CASE IV: A 33-year-old man was admitted to the Clinic on Dec. 19, 1943, because of marked dyspnea on exertion. He had been well until two years before admission, at which time he was rejected by the Army "because of his feet and eyes." Two months later he noticed a pressure sensation in the substernal and epigastric regions, aggravated by exertion and relieved by rest Shortly afterward he experienced palpitation, tight sensations in his throat, and a gradual loss of 10 pounds in weight. Six months before entry, there was swelling of the ankles of a progressive nature. The appetite was good. There were some heat intolerance and marked nervousness. The basal metabolic rate on two occasions was +19 and +11. Lugol's solution was given by the family physician for an enlarged thyroid gland, without apparent effect. There was no history of rheumatic fever or syphilis. The patient's parents were American-born and of normal height. Two brothers were 5 feet 10 inches and 6 feet, respectively. One sister was said to have long, slender feet and hands. The patient had eye trouble from birth, and as long as he could remember had been tall and thin for his age, with long, slender hands.

Fig. 7. Case IV. Long tapering fingers with characteristic spidery appearance.

Fig. 8. Case IV. Aneurysm of ascending aorta in a 33-year-old man with arachnodactyly.

The patient was pale, acutely ill, and dyspneic, appearing much older than his stated age. His face was long and narrow, with prominent supra-orbital ridges and a large, somewhat sagging jaw. Ectopia lentis was present. The weight was 175 pounds; the height 6 feet; the span 6 feet 6 inches. There was a paucity of subcutaneous fat. The muscles were hypotonic and underdeveloped. The hands were long and gracile, with a characteristic spidery appearance (Fig. 7). The patient wore a size 11 1/4 shoe. Hammer toes were present bilaterally.

The right lobe of the thyroid gland was palpable; it measured 1.5 by 2.0 cm. and was moderately soft. The chest was flattened. There were râles indicative of congestion in both bases. The heart was greatly enlarged in all diameters (Fig. 8). Systolic and diastolic murmurs were heard both in the aortic area, with extension down the left sternal border, and at the apex. Percussion revealed dullness in the region of the base of the heart. A gallop rhythm was present. The blood pressure was 200 mm. systolic and 50 mm diastolic. The liver was palpable four finger-breadths below the costal margin and was moderately tender. There was a grade 2 pitting edema of the ankles. A clinical diagnosis was made of aneurysm of the ascending aorta with cardiac hypertrophy and dilatation, grade 3, and congestive heart failure.

Fluoroscopy and roentgenography revealed limitation in the excursion of the diaphragm. There was an increase in the peribronchial markings at the left base, the right mid-lung field, and at the right

base. The heart was enlarged both to the right and left. There was marked dilatation in the region of the ascending aorta. The descending aorta appeared to be of average width. The cardiothoracic measurements were 21.3 to 31.3 cm., and the width of the ascending aorta was about 8 cm.

The hemoglobin was 12.5 gm. Erythrocytes numbered 4,950,000 and leukocytes 6,550. The differential count was as follows: polymorphonuclear leukocytes 62; band forms 4; lymphocytes 34. The specific gravity of the urine was 1.022; there was a trace of albumin, grade 1. No sugar, white blood cells, or casts were noted. There was an occasional erythrocyte. The non-protein nitrogen was 40 mg. per 100 c.c. The Hinton, Kahn, and Wassermann tests gave negative results. The basal metabolic rate on two occasions was +52 and +21.

The patient was treated for cardiac failure, but only partial compensation was achieved. It was felt that hyperthyroidism was unlikely but that it might complicate the picture, and thiouracil was therefore, given before the patient was discharged on Jan. 12, 1944. He was instructed to return after one month of complete bed rest but was too ill to do so.

A recent communication from the patient's physician stated that there had been no benefit from thiouracil and that death from congestive heart failure had occurred approximately six months after discharge. Autopsy could not be obtained.

COMMENT

Since American physicians have been aware of arachnodactyly as a clinical entity for only the past two decades, and since apparently it is more common than was previously supposed, it seems worth while to mention a few of the diseases with which the more striking clinical aspects of this syndrome may be confused.

The age of the patient will frequently confuse the picture. In the infant or rapidly growing child, especially without eye abnormalities but with sternal depression, flaring ribs, squaring of the head, pot belly and emaciation, this syndrome may be mistaken for rickets. However, the abnormally long and slender extremities, the absence of flared epiphyses demonstrable by roentgen examination, normal calcium and phosphorus studies, and perhaps obscure anomalies in the parents, should lead one to suspect arachnodactyly.

The symptoms of weakness, fatigue, moderate dyspnea on exertion, malnutrition, and a coarse systolic murmur in early childhood may focus attention on the cardiovascular system to the exclusion of what appear to be lesser anomalies. The diagnosis of rheumatic heart disease with malnutrition and rachitic stigmas may thus be made, without sufficient evidence. Rheumatic fever, however, may occur in any child. The frequent occurrence of proved rheumatic fever in the arachnodactylic child has been stressed by Young. In our second case, in spite of the absence of polyarticular involvement and a normal P-R interval, we were unable to explain the symptoms and periodic bouts of fever except on this basis.

If the patient with congenital cardiovascular disease is first seen when he reaches maturity, the frequently associated cardiac hypertrophy and dilatation, or aneurysmal enlargement with or without frank congestive failure, present a more serious and pressing diagnostic problem. Exhaustive studies may be undertaken to establish the diagnosis of rheumatic heart disease, syphilitic aneurysm, or congenital heart disease without due regard to the muscle, bone, and connective-tissue findings. Since our fourth patient presented every characteristic feature of arachnodactyly without other complicating etiologic factors, we believe it safe to state, in spite of the absence of pathologic evidence, that he had a congenital aneurysm of the ascending aorta—a manifestation of this syndrome (2).

NOTE: We wish to acknowledge the aid of Dr. W. P. Beetham in the study of these cases and to give him credit for making the diagnosis in Case IV.

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Degenerative Effects of Large Doses of Roentgen Rays on the Human Brain[1]

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IN 1936, ONE of us with the late Dr. Adolph Hartung (62) reported preliminary observations on 15 cases of brain tumor of various types, from the service of Dr. Eric Oldberg, treated with a total dose (air) of 15,000 r of high-voltage roentgen rays. Our first impressions were favorable, since occasional results were noted that had previously been unobtainable. In the twenty months from the beginning of the study until the time of the first report, no untoward effects were seen. Similar treatment has been given to selected cases since that time. Only recently have we had the opportunity of examining postmortem cases showing degenerative changes as the result of such therapy, although the literature has, from time to time, contained reports of damage from similar doses.

With the development of the fractional protracted technic of radiation therapy, after the pattern of Coutard, much larger doses of radiation were delivered to neoplasms throughout the body, including those of the central nervous system, than were used previously. The fractionated technic was particularly welcome for intracranial lesions, especially in those clinics where aggressive radiotherapists did not have adequate neurosurgical support and tumor cases were treated without the benefit of preliminary decompression.

REVIEW OF LITERATURE

The early reports of radiotherapy of intracranial growths showed the high mortality rate of 16.9 per cent (61) directly traceable to the irradiation. Less severe sequelae were common. Béclère (6) ascribed these untoward results to what he called the "prereaction," an acute hyperemia and swelling of the irradiated area, appearing from one to several hours after treatment and disappearing in from twenty-four to forty-eight hours. Froment, Delore, and Tassitch (32) measured the cerebrospinal fluid pressures both before and after treatment in five cases. They found increased values following irradiation, more pronounced with higher doses and when the pressure was previously high. Such developments could easily be fatal to a patient already in critical condition. The use of the fractional protracted technic, with a small initial dose which is increased by small daily increments, has reduced the danger of roentgen therapy even in cases without decompression. Thus, Cutler, Sosman, and Vaughan (14) recommended a diagnostic therapeutic test in cases of suspected medulloblastoma prior to operative exploration and felt that, with fractionation and dehydration, serious reactions could be avoided.

The tendency to deliver larger doses to intracranial tumors was stimulated by the observations of Bailey, Sosman, and Van Dessel (5) and Sachs, Rubinstein, and Arneson (55). These writers felt that larger doses were desirable, especially in the glioblastoma multiforme group, and that patients receiving such doses as a rule survived longer. Frazier and Alpers (29), in a paper on the gliomas given before the Association for Research in Nervous and Mental Disease in 1935, concluded, among other things, that a large proportion of patients had received inadequate amounts of radiation and that, with methods

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hitherto used, adequate doses could not be given because of the dangers of injury to the soft and bony structures of the head.

The universal failure of radiation therapy in those cases which seemed histologically to afford the best chance for success, based on the prophetic writing of Ewing (24), *i.e.*, cases of medulloblastoma and glioblastoma multiforme, and the paucity of clinical reports on radiation damage undoubtedly caused radiologists everywhere to attempt more radical therapy. When Dyke and Davidoff made inquiries about therapeutic radiation procedures for their book, published in 1942 (20), they found that Pendergrass was delivering up to 6,500 r (tumor dose) within six weeks in cases of astrocytoma and glioblastoma multiforme, repeating the dose if there were signs of recurrence; Sosman calculated a dose of 4,500 r to the center of a mid-line glioma; Brunschwig and Hamann gave 5,000 r (tumor dose) to medulloblastomas.

In cases of glioblastoma multiforme, Dyke and Davidoff gave from 1,000 to 1,400 r (air) to each of four portals, delivering the dose in about two weeks. They repeated the series four or five times, with intervals of four to six weeks. O'Connell and Brunschwig (49), reporting on Bailey's cases, list one patient who received 12,645 r (air) in six months; another receiving 15,248 r in fifteen months; and a third who was given 14,229 r in seven and a half months. Carty and Ray (11) delivered 6,000 r (air) at 60 kv.p. with low filtration into the open wound in one session, following radical surgical removal of a tumor. Sherwood Moore, discussing their paper, told of giving an identical dose, also through an open wound, but with 200 kv. and 1.0 mm. copper filter.

Rüsken (54) gave 2,700 r (air) through each of five portals (13,500 r total), using high voltage and 0.5 mm. copper filtration, to a tumor diagnosed by encephalography only. He repeated the same dose apparently, two and a half years later, when there were signs of recurrence. Jenkinson (39), treating Oldberg's cases, administered 15,558 r (air) over a period of three years to one patient, and to another 18,822 r in eight series in twenty-six months. Fried (31) tells of delivering three series of 9,660 r (air) each (28,980 total) to a large infiltrating precentral glioblastoma multiforme in a twenty-three-year-old girl and cites three other cases in which the dosage was 16,550, 22,800, and 25,000 r, respectively. Kaplan (40) has achieved the highest recorded dose, delivering four series of 9,000 r (air) each and one series of 6,000 r (air) in less than twenty-two months, for a total of 42,000 r (air). He calculated the depth dose at 25,000 r.

Some of the patients who received these large doses died and showed degenerative changes at autopsy (49), while others showed clinical evidence of a degenerative process (39). Still others, however, tolerated the treatment well and were normal clinically as long as three years later (31, 40). Among the latter were the patients who had received the largest doses.

That functional and morphological changes occurred following irradiation of the central nervous system of experimental animals was recognized soon after the beginning of radiation therapy. Exhaustive reviews of the literature on the subject have been made by Lyman, Kupalov and Scholz (43) and by Dyke and Davidoff (20).

There were discrepant reports in the early literature as to the nature and degree of the effect of both radium and roentgen rays. Danysz (15), Obersteiner (48), and Horsley and Finzi (38), using radium, observed severe vascular changes. The latter authors thought the nerve tissue was unaffected except where it was destroyed by hemorrhage. In general, the early workers with radium noted very localized changes, the degree depending on the dose. Brunner (10), using roentgen rays, concluded that the effect of radiation was particularly evident in the superficial granular cells of the cerebellum, while the fixed nervous tissues were essentially unaffected. He found no change in the blood-vessel walls, but the blood vessels were engorged and, secondary to this distention, there

occurred hemorrhages and edema of the brain.

Lyman, Kupalov and Scholz (43) found damage to both systems, as did others. They considered the damage to the nerve cells secondary to the changes in the blood supply. Nemenow (47) thought that those who failed to find changes in the nerve tissue had examined it too soon following irradiation. Some of the early work is difficult to correlate with present standards of dosage measurement, but it was apparent that the changes were directly proportionate to the dose delivered (2, 3, 16, 41) and that the vascular and particularly the nervous tissues of the young were much more sensitive than those of the adult (10, 13, 28, 37, 45, 48, 57).

Disturbances of function were noted with much smaller doses than those necessary to produce morphologic changes. Nemenow (46) was the first to study the action of roentgen rays on conditioned reflexes in dogs. He found that 2 H.E.D. (1,100 r) caused weakening of the conditioned reflexes without any morphological change. Lyman, Kupalov and Scholz (43) found that 18 to 20 erythema doses delivered fractionally through five portals directed to the posterior fossa of a dog's skull produced more serious disturbances of these reflexes. The reaction could be separated into four periods. The first period lasted one to three weeks following irradiation and the picture varied in different dogs. After one to two days taken to recover from the trauma of the irradiation, their behavior became quite normal, but the conditioned reflexes exhibited individual differences, both increased and decreased activity being noted. The conclusion was that some increase or decrease of excitability of cortical function had occurred and that these variations fell in line with the inherent physiologic constitution of the dog.

The second stage began in the second or third week and continued into the fifth week or longer. The general behavior might appear normal, but a lowering of the usual spontaneous activity was sometimes noted. The conditioned reflexes always dropped to a greater or less degree, and the unconditioned reflexes might also decrease, but seldom in proportion to the marked decrease in the conditioned reflexes. Accordingly, the authors thought that the second stage could be said, with reservation, to be one of more or less reduced cortical excitability.

The third stage began with a return of all reflexes to normal; the general behavior was also normal. Since only one dog in the series reached that period, its duration could not be stated with certainty, but work with other unreported dogs also gave the impression that a time came when the natural level of cortical excitability was in no way disturbed and the animal appeared perfectly well.

The fourth stage came five or six months or more after irradiation. Definite signs of cerebral damage then developed. The last dog in the series was killed at the end of six months. The authors concluded that there was physiologic evidence indicating that, even when radiation was directed at a single part of the central nervous system, its action was diffuse; that it involved the subcortex as well as the cortex, and that there were coincident features pointing toward a vegetative nervous influence. They felt, however, that the action was not primary on the nerve cells but on the vascular system.

Nemenow (47) practically repeated the experiments of Lyman, Kupalov, and Scholz and reached similar conclusions. Davidoff, Dyke, Elsberg, and Tarlov (16), in experiments on monkeys, also observed profound physiologic and morphologic changes following irradiation of the brain and cord. These latter workers found that the effect of massive roentgen doses was especially marked in the glia and nerve tissues and, surprisingly, that changes in the blood vessels were slight in degree.

Ellinger (22, 23) made a noteworthy contribution to the problem of the origin of the nerve tissue damage. He demonstrated an optimum lethal effect for total body irradiation of the goldfish. This level was

found at 1,500 r with roentgen rays ranging from h.v.l. 0.233 to 0.9 mm. copper. Increasing the dose up to 10,000 r (air) did not influence the mortality curve. Examination of the brains, however, revealed an increase in the histopathologic changes with the larger doses, especially in the medulla oblongata. Since the fish treated with 10,000 r died on the thirteenth day after irradiation and those receiving the smaller dose were killed on the fifteenth day, the survival time was approximately equal. This Ellinger regarded as of importance since changes in the central nervous system following irradiation require a considerable time to develop, as has been noted by many workers. It appeared important, also, that *the changes in the blood vessels did not differ greatly when either dose was used*. Ellinger considered the assumption justified, therefore, that the differences in the effects of increasing doses of roentgen rays on the brain were due to direct action of the radiation on the nerve cells. The marked radioresistance of these cells was believed to account for the longer period before injury became detectable. In consequence, the damage done to the more vulnerable tissues, e.g., blood vessels, dominated the histological picture. "*But this does not necessarily imply that the injury to the nerve cells is secondary to such changes.*"

The experimental evidence summarized above has a clinical counterpart. Flaskamp (27) found that, up to 1930, no brain injury had been reported with doses not exceeding 500 to 600 r. Goldstein (34) in 1930 reported on the high incidence of anomalies in children irradiated *in utero*, the treatment being directed to pelvic disease of the mothers. Druckmann (19), in 1929, reported periods of somnolence lasting four to fourteen days in 30 out of 1,100 children treated by epilation for ringworm of the scalp. The children were five to twelve years old and somnolence appeared six to eight weeks after irradiation. Ellinger (21) agreed with Druckmann that the symptoms were a sign of cerebral irritation.

Markiewicz (44) in 1935 described severe scalp, bone, and nerve tissue injury in a male of thirty-four years who had received an estimated 80 to 90 H.E.D. in a period of three years and a half (approximately 44,000 r, since H.E.D. indicates a unit skin dose or approximately 550 r). Cutler, Sosman, and Vaughan (14) in 1936 quoted Béclère (7), who stated in 1928 that the dangers from irradiation of the brain were either immediate from edema or delayed or latent from radiation gliosis. Cutler and his associates stated, however, that "the delayed or latent danger of gliosis is apparently quite unimportant. In some of our heavily treated cases, Bailey found slight superficial gliosis in the spinal cord. Normal nervous tissue is notoriously resistant to radiotherapy, both in man and in the experimental animal." Later in the same article, they say: "In the experimental animals it required excessive doses of radiation to damage normal central nervous system tissue and then the effect was one of small hemorrhages and small areas of necrosis, presumably due to an effect on the blood vessels rather than a direct effect on the nervous tissue. As much as 1,500 r at the rate of 300 r a day, through each of six portals, has been given to animals without any demonstrable lesions in six months."

In 1937, O'Connell and Brunschwig (49) quoted the observations of Fischer and Holfelder (26) on a man that had received roentgen therapy for a carcinoma of the temporal region. Seven years later he experienced attacks of restlessness, a feeling of heat, inability to speak, and numbness and twitching of the left hand and foot. Exploration showed the brain blue and full. There was no evidence of metastasis. Biopsy revealed only a localized amyloid change which Fischer and Holfelder thought to be the result of irradiation.

O'Connell and Brunschwig likewise quoted Markiewicz's case, and the reports of Lorey and Schaltenbrand (42) and of Schaltenbrand (56). These reports involved two cases. The first was that of a five-year-old girl who was treated for ring-

worm of the scalp. She had a complete epilation in three weeks. Three months later, the hair grew in on the left side but not on the right. One year after treatment, epileptic attacks and left-sided weakness were observed. A year later there occurred an acute episode, with fever, convulsions, and a left hemiparesis. At the age of thirteen (seven years after treatment) the left side of the body was underdeveloped and, although major epileptic attacks were less frequent, numerous minor attacks continued. Roentgen examination of the skull revealed changes which agreed well in location with the atrophic and telangiectatic changes in the right side of the scalp. A well marked atrophy of the skull was seen and there was a superficial calcification within the cranial cavity. An encephalogram showed the right lateral ventricle to be wider than the left, suggesting atrophy of the right hemisphere. Lorey and Schaltenbrand believed that the roentgen rays had injured the scalp, cranium, and meninges. They thought that a dural hematoma had developed in this area, injuring the cortex and giving rise to underdevelopment, epilepsy, and a spastic hemiparesis of the opposite side. Finally, inflammatory products in the meninges had calcified. These presumptions were later verified by trephination, a pachymeningitis hemorrhagica being disclosed.

Schaltenbrand's case was that of a twenty-one-year-old woman who had received roentgen treatment for a microsporon infection of the scalp when nine years of age. During the period of treatment, there was pyrexia on two occasions, with some signs of bronchitis. At fifteen years of age, after the child had been nervous and emotional for some time, she was brought to the clinic because of delirium and fever. She had aphasia, deviation of the head and eyes to the left, and a left flaccid hemiparesis. There were clonic twitchings of the right arm and face. Her mental state improved gradually, the aphasia and hemiplegia disappeared, and the attacks of twitching of the right face and arm became less frequent. An encephalogram showed a symmetrical dilatation of the ventricles. At the age of twenty-one, the patient returned, complaining of increase in frequency of the epileptic attacks. Most of the hair of the scalp was absent; its skin was thin and atrophic. Roentgen films showed patchy defects in the cranium, and in one place there was some flaky intracranial calcification. Schaltenbrand thought that the roentgen rays had injured the cranium and brain at the age of nine and that, after a latent period of three years, an encephalitis-like illness resulted, which gave rise to the right hemiparesis and epileptic seizures.

O'Connell and Brunschwig also presented several of their own cases. The first two patients had not received radiation therapy and served as controls. The third patient was a man of 45 with signs and symptoms of a right frontal lobe tumor. Craniotomy by Dr. Percival Bailey revealed an extensive glioma. A biopsy was taken and a decompression was done. The microscopic picture was that of a cellular glioma, classified as a protoplasmic astrocytoma but with evidences of malignancy. From April 24 to Sept. 12, 1933, the patient received 12,645 r (air) through multiple portals, at 200 kv., with 1.0 mm. copper and 1.0 mm. aluminum filter. Transitory erythema and permanent epilation occurred. The patient returned to work. The decompression remained soft until March 1936. The patient then "lost interest in things," a left hemiparesis appeared, and the decompression became tense. He received 630 r of roentgen therapy but gradually passed into coma and died on April 27, 1936. Autopsy was performed eleven and a half hours later, but the brain had been fixed previously by arterial injection. The right frontal region was 25 per cent larger than the left and contained a large tumor. Histologically, this was more cellular and of a somewhat more malignant type than at biopsy three years before. The authors summarize the findings as follows: Definite and generalized degenerative changes were

present with a marked increase in lipochrome substance within the cells. The nerve cells were affected most and the neuroglia to a lesser extent. The blood vessels were for the most part unaffected. There was no evidence of any mesodermal reaction, though fat-laden macrophages were to be found around most of the small vessels.

The fourth patient in the series, aged 32 years, had signs and symptoms of a left temporal lobe tumor. Craniotomy by Dr. Bailey revealed a deep mass; a biopsy and a decompression were done. The microscopic appearance was that of a protoplasmic astrocytoma with some cellular polymorphism and multinucleated cells. There was also thought to be oligodendroglia in the growth. Between April 7 and 18, 1933, the patient received 8,178 r (air) through multiple portals; between May 29 and July 5, 1934, he received 7,250 r (air). A severe dermatitis of the scalp followed the second treatment. The attacks continued, although at longer intervals and, apart from this, the patient was at first considerably improved. Later, he lost his appetite and displayed weakness, listlessness, and loss of energy. The decompression stayed soft and flat. Vomiting occurred and there was numbness of the left hand and leg. Eventually drowsiness ensued and death occurred Jan. 25, 1935. At no time was there bulging or tenseness of the decompression. An autopsy was done less than three hours after death. In the left hemisphere was a large mass of abnormal tissue extending from the anterior portion of the left temporal lobe to within 2 cm. of the occipital pole. One cyst, 2 cm. in diameter, was present in the center of the mass and there were numerous surrounding cysts. There was considerable edema of the left hemisphere. Histologic examination revealed an extensive degenerative process with some areas of marked astrocytic proliferation, undoubtedly tumor. There was no evidence of malignant transformation. The author's summary of findings is as follows: "In this brain, which had received larger doses of radiation than the previous one, much more pronounced degenerative changes were present. The process affected not only the nerve cells, but also the astrocytes, microglia, and possibly the oligodendroglia. The blood vessels were involved to a slight extent only. The clasmatodendrosis and myelin destruction of the temporal lobe might be accounted for by the presence of the tumor but certainly not the widespread degenerative changes affecting all parts of the cortex."

The fifth case was one of medulloblastoma cerebelli. The patient, a male child 4 years old, entered the hospital in October 1932 with a history of unsteadiness of gait of six months' duration. A clinical diagnosis of a tumor of the vermis was made. At operation, a typical medulloblastoma was found. A biopsy specimen was taken and a decompression done. The child received 13,789 r between Nov. 11, 1932, and April 17, 1934, 200 to 300 per sitting being given either rather continuously or in series with varying rest periods. Irradiation caused the symptoms to disappear and later had the same effect on the lumbar pain which developed in April 1933 and again in March 1934. Subsequently, irradiation proved unavailing and the child died in February 1935. Postmortem it was found that the tumor had spread widely through the subarachnoid space. "Widespread changes of type previously described were present. They affected the nerve cells, neuroglia, microglia and even the blood vessels. The nerve cells showed more definite evidences of degenerative changes here than in any other case, no doubt due to the age of the patient."

The sixth case of O'Connell and Brunschwig was also one of cerebellar medulloblastoma, in a child of five and a half years. The patient received 14,229 r (air) from Sept. 26, 1933, to May 7, 1934, and died less than one month following the last treatment. "The changes," said the authors, "resembled those in the brain of Case 3, the nerve cells being mainly affected. These were swollen and vacuo-

lated, their nuclei being displaced and heavily stained."

In their discussion, O'Connell and Brunschwig definitely eliminated the possibility that any of the changes which they attributed to the effects of radiation were the result of either postmortem changes or the presence of the tumor. They referred to the work of Stern (60), Casper (12), and Biondi (9). They also called special attention to their two cases of medulloblastoma. The patient who had lived almost a year following irradiation showed much greater changes than the one who died within one month of the treatment. They believed with Schaltenbrand that the time which has elapsed after irradiation may be an important factor in the production of degeneration. Individual variations of sensitivity to radiation, as with other tissue, was also considered to play a role.

Summarizing the changes in the various types of tissue examined, O'Connell and Brunschwig observed that in only one brain were there well marked alterations in the vascular system in both the cortex and medulla; in the remaining cases, no vascular reaction other than slight thickening of the media was seen. They concluded that it seemed certain that in none was the vascular change primary or the factor responsible for the alterations in the nervous tissue itself.

In 1939, Sosman (58) stated that the dangers following irradiation in treatment of pituitary adenomas were real but rare. He had not observed a case of edema of the brain, which is so often mentioned as a possibility. He believed the nerve tissues of adults would stand dosage up to 6,000 r in any one area; dosage should be below that level to avoid injury to the vessels and subsequent fibrosis, gliosis, or necrosis.

In 1940, Pendergrass, Hodes, and Groff (52), reported 3 cases of carcinoma of the scalp in which large doses of radiation were followed by radiation damage. All three patients showed clinical, operative, and histologic evidence of bone infection. A possible strangulation of the blood vascular system within the bone by radiation, as mentioned by Ewing (25), was considered to be an etiologic factor. It was likewise pointed out that destruction of the normal protection mechanism of the body may occur with large doses of radiation. In one patient bone necrosis developed. All had symptoms of increased intracranial pressure and signs referable to the area of treatment. In all cases the first craniotomy showed a focal subdural abscess. One patient died of a purulent encephalomeningitis and one of a streptococcic meningitis, obliterative endarteritis, and brain softening. This latter patient had a large abscess below the site of treatment and a malignant metastasis from the scalp to the contralateral temporal lobe. The authors were assured by Dr. B. J. Alpers, pathologist, that the findings were primarily due to infection, with little evidence to suggest brain degeneration of the type seen following irradiation.

Dyke, in a discussion of the paper by Pendergrass and his associates, stated that he had had several cases in which an epidural abscess developed during roentgen treatment for a glioma, weeks to months after operation. In addition, Dyke had treated 31 patients in the operating room with large doses of roentgen rays delivered at one session. He gave from 2,000 to 3,000 r at 200 kv. Five patients had died from infections, which number, he says, "is altogether too great for a hospital in which good aseptic technic is used and a large amount of brain surgery is done." Also, infections occurred in 3 of 10 monkeys irradiated with large doses of roentgen rays, and death from meningitis or cerebral abscess followed. Some of the monkeys that were irradiated showed no immediate effects but later exhibited degeneration of the brain.

In 1940, Sosman, discussing a paper by Kaplan (40) on irradiation of brain tumors, stated that experiments had been made that convinced him that if more than 6,000 r were given in the brain itself in any one series of consecutive treatments, there was an approach to brain damage; with over 6,000 r, brain damage resulted, and with

10,000 to 12,000 r in one series the patient might be killed. In children, he felt that the safe limit was 3,000 to 4,500 r in one series.

Jenkinson and Oldberg (39), in 1942, reported a case of glioblastoma multiforme in which treatment was begun in September 1936 and totalled 15,558 r (air) over a period of three years, most of it during the first year. Five portals were used. There was rapid improvement following the first series and this continued until July 1939. Then, although the patient felt well, he had difficulty in talking and in controlling head movements, and he lacked judgment. A neurological examination by Dr. Roland Mackay revealed no evidence of the original symptoms of tumor. Dr. Mackay attributed the neurological findings to brain atrophy, which he believed to be due to radiation. The application of roentgen rays in this case was intensive and quite general, according to the authors.

AUTHORS' CASES

Our own report concerns 6 patients. In 4 of these the tumors were histologically verified prior to irradiation. The other two undoubtedly had tumors but they were deep-seated, and specimens could not be obtained at operation. All received postoperative roentgen therapy. From three to five portals were used, from 5 to 10 cm. square. The initial dose was usually 150 r, increased to 300 r within three or four treatments. (In Case I doses in excess of 250 roentgens were not tolerated.) One portal was treated each day. Five or six treatments were given each week, if possible, until the series was completed. The shortest series ran 32 days, totalling 9,000 r in air and 6,150 r tumor dose; while the longest series took 106 days for 14,840 r (air) to the skull (8,809 r tumor dose) and an additional 2,700 r to a posterior nasal lesion.

Three separate machines were used. The voltages were 190, 200, and 220 kv.p., with filters of 0.75, 0.5, and 1.0 mm. of copper, respectively. The half-value layers were 1.0, 0.75, and 1.56 mm. of copper. The dosage rates were 20, 49, and 33 r per minute (air). The highest dose to any one portal was 3,200 r (air) delivered in thirty-two days. Usually transient bright red erythema occurred, and was followed by epilation and dry desquamation. Moist desquamation was not observed. The epilation was permanent.

Following irradiation, there was usually a period of good health (except in Case I). Within a period of a few months to nearly two years there developed evidence of severe damage to the brain. Three of the patients came to autopsy.

CASE I: A white male, aged 44, was admitted to the Illinois Neuropsychiatric Institute on Feb. 15, 1942, with difficulty in speech and right-sided weakness present since the preceding November. He had noticed clumsiness of his right hand in July 1941, and by November there was a definite right-sided paresis, with subjective right astereognosis, personality deterioration in the nature of "childishness" and faulty judgment, and some difficulty in choosing his words. These symptoms led to admission to another hospital, where a left parietal craniotomy was done on Jan. 13, 1942, and a deep-seated glioblastoma multiforme of the parietal lobe was verified histologically. There was no attempt at extirpation, and the bone-flap was allowed to ride loosely to afford decompression. The postoperative course was uncomplicated save for a right-sided convulsive seizure on the twelfth postoperative day. No further seizures occurred and the patient was transferred to the Institute for deep x-ray therapy three days later.

On admission the patient was conscious but disinterested, with a fatuous smile on his face and in no apparent distress. He had papilledema of three diopters, a complete right homonymous hemianopsia, a complete right hemiparesis, right-sided tendon hyperreflexia, patellar and ankle clonus, and a right Babinski sign. He exhibited such severe aphasia that he could speak only in monosyllables and he was usually incontinent of urine and feces.

From Feb. 11 to May 27, 1942, 57 roentgen-ray treatments were given through right and left parietal, vertex, and frontal portals, 10 cm. square. Treatments were scheduled daily, but the poor condition of the patient caused intervals of two or three days without treatment. The total dose in air was 13,000 r, while the calculated dose to the center of the tumor was 7,758 r. There was no observable clinical improvement. Early in the course of radiation therapy the patient was somewhat more unresponsive, and at times his decompression became rather tense. Later he returned to his previous state and then slowly declined. Soon his only response was a weak smile at the physician on rounds

and he became slowly and progressively more emaciated and unresponsive until his death on Oct. 9, 1942, nine months after operation and four and a half months after completion of roentgen irradiation. At no time following the completion of radiation therapy was there evidence of pressure in the operative wound. The resemblance to a patient suffering from general paresis in its late stages was frequently noted.

Postmortem examination was made five hours after death. Gross examination of the brain, which was fixed in a 4 per cent solution of formaldehyde, showed herniation of the left gyrus cinguli and an area of surface extension of tumor some 5 × 6 cm. in diameter in the left parieto-occipital region. The tumor proved microscopically to be a typical glioblastoma multiforme. Examination also disclosed a confluent pneumonia of the upper lobe of the left lung, suppurative bronchitis, generalized atheromatous degeneration of the aorta, coronary arteries and heart valves, and cloudy swelling of the liver.

Representative sections of the cerebral and cerebellar cortex on both sides were stained, in this instance, with thionin by Nissl's method, Bielschowsky's method for neurofibrils, Oil Red-O for fat, and Weil's method for myelin sheaths. Practically every cell in the cortex was filled with fat—a veritable disaster. The nerve cells, glia cells, endothelial cells, and even the ependyma all contained fat. Even in the depths of the white matter the fat was abundant, especially in the endothelial and adventitial cells. The lipochrome substance in the ganglion cells was easily visible, in the sections stained with thionin, throughout the cortex and in large amounts. Though the Betz cells still contained Nissl substance and as a whole appeared normal, there was extremely marked chromatolysis in large numbers of the other ganglion cells throughout the cortex. The Nissl substance was replaced by vacuoles. There was little, if any, chronic cell change in the nature of shrinkage or sclerosis, but nearly all damage was evidenced by dissolution of tigroid substance, replacement by the lipochrome pigment, darkening and eccentricity of the nuclei.

With the fat stain, the capillaries were clearly outlined by the fat contained in their walls. There were evident, throughout the cortex and white matter, mild perivascular infiltrations about the small vessels, composed chiefly of lymphocytes and macrophages containing greenish blood pigment. The large blood vessels appeared relatively normal.

The leptomeninges showed moderate thickening and light infiltrations with lymphocytes and especially many pigment-filled macrophages. Beneath the pia mater were occasional small focal collections of lymphocytes.

Weil stains showed no massive lesions of the white matter, but broken up myelin sheaths were easily singled out in the cortex, running their interrupted course across the section. Others were extremely tortuous with many knobby excrescences.

The pathological alterations were as pronounced in the cerebellum as in the cerebrum.

Comment: This was the first brain to be examined thoroughly. In view of the extent of the lesions, we determined to make a more careful examination in subsequent cases, after optimum fixation.

CASE II: A 30-year-old white woman was first admitted to the Illinois Neuropsychiatric Institute on Dec. 16, 1941, because of increasing irrationality and stupor over the preceding four days. The history indicated that the patient had suffered generalized convulsive seizures since a fall on the ice at the age of 7 and some time later had begun to have right-sided focal motor seizures as well as right-sided sensory seizures, in the nature of formication. Persistence of the seizures, despite phenobarbital medication for four years, led to her admission to another hospital, where the findings of mental retardation, slowness of alternating movement on the right, right lower facial weakness, spastic weakness and agraphesthesia of the right lower extremity were recorded. On May 5, 1938, a left central osteoplastic exploration was made and a large subcortical cyst containing some two ounces of black syrupy fluid like "dirty motor oil" was evacuated. The cyst wall contained dark grayish, friable tumor tissue but, because of the central location, extensive dissection was not attempted. Microscopic examination showed an astrocytoma undergoing malignant change. The postoperative course was uncomplicated and from May 16 to May 25, 1938, a total of 1,995 r of radiation (air) was given by a technic comparable to our own. The tendency to convulsions persisted despite intensive medication, and they continued to occur at about monthly intervals. The patient was otherwise well during this period of three years and seven months until four days prior to admission, when she became increasingly irrational, actively hallucinatory, and mute. Her family physician suspected recurrence of increased intracranial pressure and referred the patient to the hospital.

Examination showed the well healed operative scar and its associated decompression to be quite flat and under no tension. The patient was at times entirely mute and negativistic, at others silly and verbose, and had frequent hallucinations. She was very dehydrated, but despite this, the remainder of the neurological examination was negative. She was felt to be in an acute psychotic episode and made an excellent recovery after treatment of the dehydration. Because of the malignant appearance of the previously incompletely removed tumor tissue, deep x-ray therapy was instituted. The patient completed the course as an out-patient, being quite well and having good insight into her recent psychotic episode. She was given, from Dec. 22, 1941, to March 16, 1942, 47 roentgen-ray treatments for

a total of 15,120 r (air) equally divided between five portals (left anterior frontal, posterior occiput, left and right lateral temporal, and vertex). Portals 10 cm. square were used. The dose in the center of the tumor site was calculated at 8,661 r.

The patient continued to be quite well, receiving 1 grain of phenobarbital each night, and had only a rare light seizure but grew weak and tired and apathetic until suddenly, in November 1942, she became paralyzed over the entire right side and severely aphasic. She grew progressively more stuporous and, with the onset of incontinence, was readmitted to the hospital on Jan. 11, 1943.

Examination on this last admission showed complete epilation, depression of the operative decompression, complete right hemiplegia, right-sided hyperreflexia and pathological reflexes, and severe aphasia. The patient was conscious but responded poorly. It soon became necessary to feed her by tube and, though there was never any evidence of pressure on the decompression, she became slowly weaker and died March 19, 1943, after two months of this all too familiar vegetative existence, one year after completion of x-ray therapy.

The brain was removed immediately after death and showed, besides a slight herniation of the left uncus, a ragged cavity some 4.0 × 3.5 cm. in diameter, containing viscid xanthochromic fluid in the left cerebral region. Blocks were immediately cut from numerous areas of the cortex of both cerebral hemispheres, from the cerebellum, basal ganglia, and brain stem. From each area portions were fixed in Zenker's fluid, Bouin's fluid, 4 per cent aqueous solution of formaldehyde, 95 per cent alcohol, Mueller's fluid, Weigert's gliabeize, Cajal's formalin-bromide, and Regaud's fluid.

Examination of the rest of the body revealed antemortem thrombi in the iliac veins, but nothing else of importance. In the brain was a multicystic lesion in the left cerebral hemisphere, extending in the centrum ovale from anterior to the head of the caudate nucleus posteriorly to the level of the splenium of the corpus callosum.

Microscopic examination showed in the cerebral cortex a universal and severe loss of Nissl substance with darkening and eccentricity of the nuclei. Many cells were totally devoid of cytoplasmic color and many were vacuolated. The Purkinje cells of the cerebellar cortex were observed to have suffered less, and the Betz cells were scarcely affected. The leptomeninges over the cerebral cortex generally were moderately thickened and infiltrated with the cells of a chronic inflammatory exudate, amounting in certain small localized areas to a chronic meningitis, through the appearance of perivascular infiltration of lymphocytes and histiocytes. Fat was demonstrable in droplets in every type of cell from ganglion cell, astroglia, microglia, to adventitial cells, endothelial cells, and ependyma in all the portions examined. The extent of the process was generalized, excessive fat being demonstrable even in the Purkinje cells of the cerebellum and the nerve and glia cells of the upper cervical cord.

There was also observed a diffuse and generalized increase in the fibrillary glia, amounting in certain areas to a veritable gliosis. Many cytoplasmic glia were seen, and clasmatodendrosis was especially evident in the Bergmann cells of the cerebellar cortex, where the fragmentation was extremely severe. Though fragmentation of the astroglia of the cerebral cortex was evident, particularly the protoplasmic ones, it was not nearly so striking as that seen in the Bergmann cells. The impregnations were not very successful for demonstration of oligodendroglia and microglia, but ameboid glia and clasmatodendrosis were well shown thereby. Many examples of varicose, fragmented, and swollen myelin sheaths were evident in all areas of the cortex and somewhat more so in the subcortex. Bielschowsky's method showed considerable swelling and fragmentation of the nerve fibers of the subcortex.

The pathologic alterations described above were more intense in the cortex of the left hemisphere in the central region but were present throughout the cerebrum and the cerebellum.

The region of the multicystic lesion was found to contain remnants of tumor consisting of fragmented glia cells with pyknotic nuclei and swollen cytoplasm. There were extensive degeneration and much overgrowth of connective tissue and abnormal blood vessels. No mitosis was found, but a few cells were multinucleated. Except at the tumor site, the blood vessels appeared fairly normal.

Comment: Such psychotic episodes after irradiation of brain tumors have been described in several cases by Benedek (8). Inflammatory-like changes following irradiation have been noted by others, especially Lyman, Kupalov, and Scholz (43).

CASE III: A male, 52 years old, was first admitted to the Illinois Neuropsychiatric Institute on Oct. 23, 1941, complaining of severe left-sided headache for eleven months. It was impossible to obtain an adequate history but, since the development of the headaches, he seemed to have undergone periods of alternate euphoria and depression. In the three or four months prior to his admission he had lost 11 pounds in weight, experienced pain in the left eye and ear, and had daily morning nosebleeds. In the same period he had numerous seizures of weakness and at times became unconscious. He had been seen for the nasal bleeding in September, at which time only an ulceration and deflection of the nasal septum were visible. Examination on admission showed marked tenderness of the entire left scalp, prominent veins in the left temple, anosmia on the left because of the blood-clogged naris, and bilateral papilledema.

Ventriculography, Oct. 29, 1941, revealed an ex-

panding lesion in the left frontal lobe and was followed immediately by a left frontal craniotomy. Through a cortical incision, a large mass was encountered on the medial and inferior aspect of the lobe, and much of it was removed by suction, so that the roof of the orbit was widely exposed. No decompression was left and the dura mater was closed tightly. The tumor proved to be a colloid carcinoma, and similar tumor tissue was later obtained by biopsy from the nose, high on the left posterior wall.

The immediate postoperative course was uncomplicated, and the patient was discharged the sixteenth postoperative day, Nov. 14, 1941, after deep x-ray therapy had been started. He was readmitted ten days later for ligation of the left femoral vein because of left popliteal thrombosis and made a rapid recovery. He continued his x-ray therapy as an out-patient and from Nov. 14, 1941, to Feb. 10, 1942, he received 49 roentgen treatments for a total of 14,840 r (air) to right and left parietal, frontal, vertex, and occipital portals, 10 cm. square. The dose in the center of the intracranial tumor was calculated at 8,809 r. In addition, 2,720 r were delivered to three facial portals, mainly the left anterior. This radiation was not considered in calculating the intracranial dose. Some of the cranial portals were angulated toward the posterior nasal lesion.

The patient failed to return to the dispensary except once shortly after completion of the roentgen therapy and was not seen again until April 8, 1943, when he was again admitted to the hospital because of recurrent headaches and cachexia. The history indicated that he had improved considerably in the spring and summer after the roentgen therapy, though he had continued to have frequent mild epistaxis. In December 1942, headaches in the left frontal and temporal regions had recurred and he had become weak, apathetic, and bedridden. Severe vomiting had supervened shortly prior to admission.

Examination at this time showed the tumor in the left naris easily visible, necrotic, bleeding, and foul. There was also evidence of orbital invasion, in the form of hard, nodular masses palpable in the medial and inferior portion of the left orbit, displacing the bulbus laterally, though there was no impairment of extraocular movements or pupillary reactions, and no papilledema. There was some secondary optic atrophy bilaterally, and tendon hyperreflexia on the right but no other localizing neurologic signs. The patient was emaciated, cachectic, and somewhat dehydrated; his state of consciousness was such that he could be aroused only with much difficulty to make unintelligible sounds in a weak voice but could not be induced to co-operate.

Treatment was supportive and palliative. The patient became progressively weaker and died on May 24, 1943, one year and seven months after operation, and one year and three months after completion of roentgen irradiation.

At necropsy there were found metastases in the pleura, liver, and right ilium, patchy bronchopneumonia, healed tuberculosis of the right pulmonary apex, prostatic hyperplasia, cholelithiasis, and fibrous adhesions of the right pleura.

The brain and spinal cord were both removed immediately after death. The tumor had invaded and destroyed both cribriform plates and the sphenoid bone back to the tuberculum sellae and involved the ethmoidal and sphenoidal sinuses, as well as the left frontal sinus, which was markedly ballooned. The roofs of both orbits were intact, but that on the left was pushed upward. The tumor had invaded the left frontal pole and orbital gyri, but had not crossed the midline, and extended back to involve slightly the caudate nucleus and globus pallidus. There was a light brownish leptomeningeal infiltration over the inferior surface of the brain in the sylvian fissure and on the dorsum of the cerebellum and vermis.

Representative sections from different areas of the brain and spinal cord were taken and placed immediately in numerous fixatives (Mueller, Bouin, Zenker, 10 per cent formalin, Cajal's formalin-bromide, Regaud, 95 per cent alcohol, Weigert's gliabeize). Preparations were made by freezing, paraffin, or celloidin technic and stained by Masson's trichrome, hematoxylin-eosin, thionin, van Gieson, Holzer, Weigert-Pal, Oil Red-O, and methylene blue-eosin, and impregnated according to the methods of Cajal, Hortega, Bielschowsky, Perdrau, and others.

The thionin-stained sections of this brain showed a considerable and widespread thickening and light cellular infiltration of the leptomeninges extending even into the cervical region. The infiltration consisted chiefly of lymphocytes and pigment-filled macrophages. In the pia mater and the molecular layer of the entire cerebral cortex, there was a mild cellular increase consisting mainly of microglia. There were innumerable cells of this type whose processes were beautifully outlined by the contained blood-pigment stained bright green by this method. There were obvious light perivascular infiltrations of lymphocytes and pigment-filled macrophages throughout all areas of the cerebrum and cerebellum, more marked in the frontal areas than elsewhere.

The nerve cells of the entire cerebral cortex had suffered widespread and severe damage in the sense of marked lysis of Nissl substance and nuclear displacement toward the apical dendrite. These changes were more pronounced than in any of the other brains examined; they were equally severe on the side opposite the lesion and were present throughout the hemispheres. With the Nissl stains, the greenish-yellow lipochrome substance was easily visible in a large proportion of the cells. The Betz cells showed less chromatolysis than the lesser nerve cells, but the fat in them was abundant and easily visible. These changes were again most severe in the frontal cortex and least of all in the occipital re-

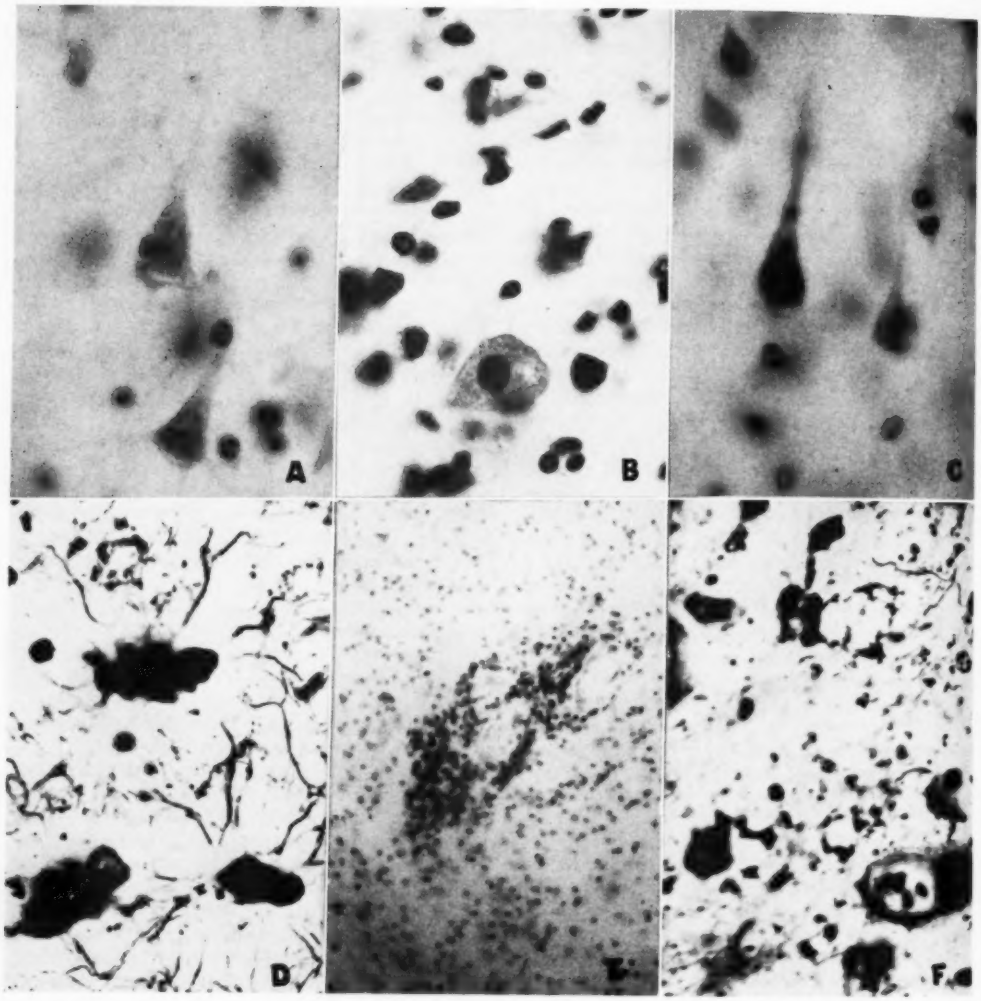

Figure 1

A. Cortical neurones from the cerebrum. Large vacuoles, Nissl granules gone, nuclei diffusely stained. Case I. Thionin stain.
B. Cortical neurone from the cerebrum. Swollen, Nissl granules gone, nucleus heavily stained. Case II. Thionin stain.
C. Cortical neurones from the cerebrum. Shrunken, nuclei displaced. Case II. Thionin stain.
D. Fibrillary neuroglial cells from the subcortex with swollen bodies and displaced nuclei. Case II. Hortega's silver carbonate.
E. Perivascular infiltration with lymphocytes and plasma cells in the cerebral subcortex. Case II. Thionin stain.
F. Clasmatodendrosis of protoplasmic neuroglia from the cerebral cortex. Case II. Hortega's silver carbonate.

gion, though clearly present in the latter. There was everywhere an obvious and widespread increase in the oligoglia.

The sections stained with Oil Red-O showed an overwhelming amount of fat contained in cells of all types and in all regions. These fatty deposits were definitely more severe than in any of the previous cases, were very evident in the cervical region of the spinal cord, and even involved the lumbosacral enlargement. Fat was observed in large amounts also in the Purkinje cells and in every nuclear structure of the entire brain with the possible exception of the substantia nigra, whose cells appeared relatively well preserved. There was a widespread and notable in-

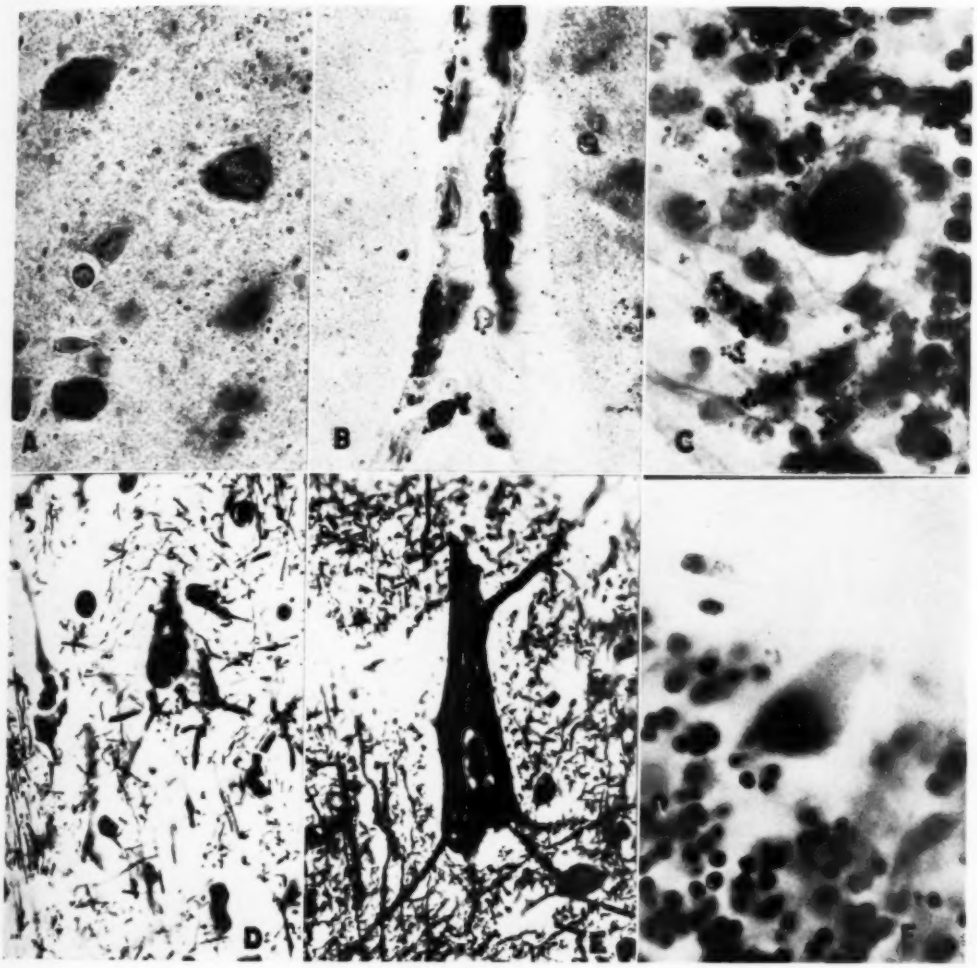

Figure 2

A. Cortical neurones from the cerebrum. Heavy accumulation of fat. Case II. Oil Red-O.
B. Cortical capillaries in the cerebrum. Heavy deposits of fat in the endothelial cells. Case I. Oil Red-O.
C. Purkinje cell layer of the cerebellum (molecular layer to the left). Heavy deposits of fat in a Purkinje cell and in surrounding glial and endothelial cells. Case III. Oil Red-O.
D. Cortical neurone from the cerebrum. Displaced nucleus. Neurofibrillae destroyed. Case I. Bielschowsky's method.
E. Giant Betz cell relatively normal. Case I. Bielschowsky's method.
F. Purkinje cell. Nissl granules gone, nucleus displaced and heavily stained. Case II. Thionin stain.

crease in the astrocytes, with many giant forms and scattered instances of clasmatodendrosis. Hortega's method showed many microglia throughout the brain in apparently greatly increased numbers, containing fat droplets and green pigment. In none of the sections were any pathological changes found in the blood vessels themselves, either of the leptomeninges or brain tissue, except for the above noted perivascular infiltration.

Summary of Pathological Alterations

From the foregoing account, it is evident that the pathological changes following irradiation of the brain are widespread and affect all of the cellular elements. The nerve cells of the cerebral cortex are almost universally degenerated, the least change

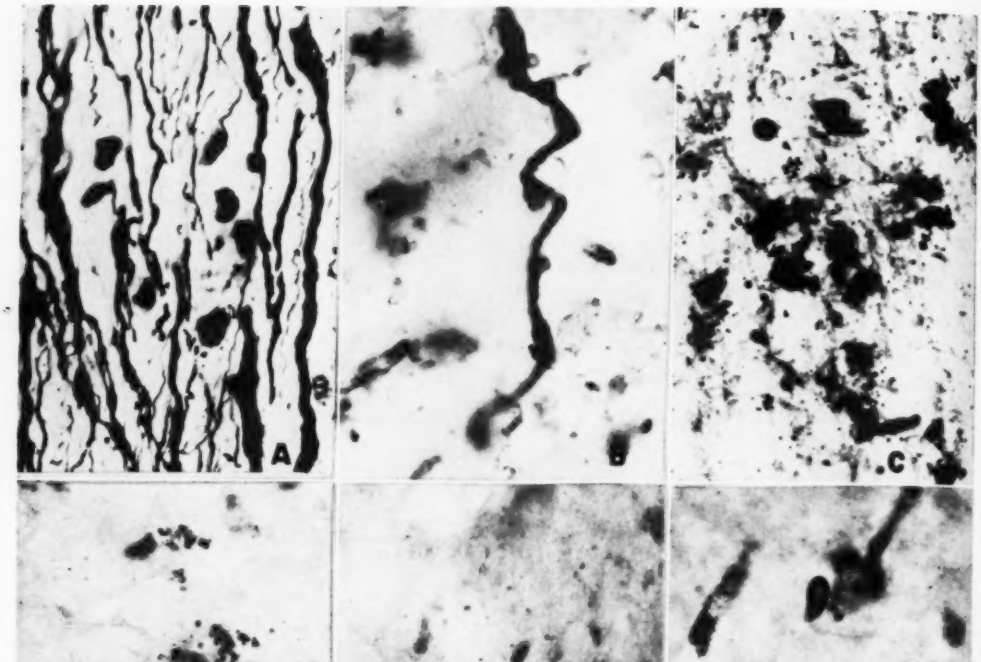

Figure 3

A. Swollen and fragmented axis cylinders from cerebral subcortex. Case II. Bodian's method.
B. Swollen and fragmented myelin sheaths in cerebral subcortex. Case II. Weigert's method.
C. Fatty deposits from fragmented myelin sheaths in cerebral cortex. Case II. Oil Red-O.
D. Fatty deposits in neuroglial cells of the plexiform layer of the cerebral cortex. Case I. Oil Red-O.
E. Microglial cell in cerebral subcortex containing fatty granules. Case II. Oil Red-O.
F. Cortical capillaries in cerebrum containing fatty deposits in endothelium. Case III. Oil Red-O.

being seen in the large Betz cells of the motor cortex (Fig. 2, E). The nuclei are almost always diffusely stained (Fig. 1, A, B, C) and eccentrically situated (Figs. 1, A, C and 2, A, D); the neurofibrillae are disintegrated (Fig. 2, D); the tigroid substance is gone (Fig. 1, A, B, C); the cytoplasm is swollen (Fig. 1, B), shrunken (Fig. 1, C), or more often vacuolated (Fig. 1, A); excessive amounts of fat have accumulated (Fig. 2, A). The neuroglial cells, especially the protoplasmic cells of the cortex, are fragmented (Fig. 1, F) and the fibrillary neuroglial cells are swollen (Fig. 1, D); fat has accumulated in their cytoplasm (Fig. 3, D).

There is an increase in the number of microglia cells of huge size with their proc-

esses laden with fat (Fig. 2, C and 3, E) or greenish pigment. The capillaries (Fig. 3, F) and other small blood vessels have excessive amounts of fat in the endothelial and adventitial cells (Fig. 2, B). The myelin sheaths are swollen (Fig. 3, B) and fragmented, giving rise to accumulations of fat in the white substance (Fig. 3, C). The nerve fibers also are swollen and fragmented (Fig. 3, A). In the adventitial spaces are accumulations of fat-laden macrophages and also lymphocytes and plasma cells (Fig. 1, E). In the leptomeninges are accumulations of lymphocytes, plasma cells, and macrophages. There is, therefore, a universal degenerative change affecting all parts of the brain and all its cellular elements, even of the cerebellum (Figs. 2, C and F).

DISCUSSION

What is the significance of the changes described in the preceding paragraphs? They cannot be due solely to the presence of a neoplasm, nor the effect of increased intracranial pressure. We have controlled these observations by examination, in the same manner, of brains containing glioblastomas but not subjected to irradiation or having only minimal or moderate irradiation, and have found no such universal cellular disaster. There are often cellular degenerative changes in the neighborhood of the neoplasm and even degeneration of nerve fibers at a distance. These changes associated with the presence of a neoplasm have been often described (12, 30, 53).

Even the presence of metastases from a malignant growth elsewhere in the body does not produce such universal degeneration (33, 36). The cachexia in the third case might account for the fatty infiltration which involved the lumbosacral spinal cord as well, but even fatal starvation does not produce the other changes noted (35). Other possible causes such as poor fixation, postmortem necrosis (59, 63), intoxication, etc., do not come into question. We are forced to conclude that the changes are the result of excessive radiation.

Fig. 4. Case IV. Note sunken decompression.

This conclusion is strengthened by the clinical course in other cases, also, in which we have not been able to do a necropsy. We cite as examples three such instances.

CASE IV: A woman aged 40 was admitted to the Illinois Research and Educational Hospital on Jan. 9, 1936. For nine years she had suffered from convulsions without focal signs so far as could be determined. Lately her vision had failed and she came, on this account, to the eye clinic, where it was found that she had choked optic disks. The optic disks were elevated 3 diopters. There was a right lower facial weakness and possibly an aphasic disturbance, although it was difficult to be sure because the patient spoke only Polish and was very unco-operative. On Jan. 14, 1936, she had a convulsion which began in the right face and neck. On Jan. 28 a ventriculogram showed displacement of the ventricles to the right. The following day a left osteoplastic exploration disclosed a large tumor lying just below the surface in the parietotemporal region. Biopsy was done and the bone removed so as to leave a large decompression. The diagnosis was astrocytoma, and x-ray irradiation was begun.

From Feb. 22 to April 22, 1936, the patient received 51 roentgen-ray treatments for a total of 15,000 r (air), almost equally divided between right and left temporoparietal, frontal, vertex, and occipital portals Portals 10 cm. square were used in the

right and left temporo-parietal regions, and 5 cm. square over the other areas. The depth dose was calculated at 6,403 r. Near the end of the course of treatments, the aphasia improved and the patient spoke Polish and, later, English fairly well.

The patient was discharged from the hospital on Feb. 22, 1936, and was followed in the out-patient department. On Oct. 5, 1936, she was feeling well; the decompression was soft but bulging. She remained without complaints, doing her work and apparently as well as usual—although it was impossible to get any detailed account from her or her family—until Dec. 24, 1942, when she began to have twitching of the right side of the face accompanied by inability to speak. From that time, at least, she began to decline rapidly. On Jan. 7, 1943, when she was readmitted to the hospital, she was found to have a right lower facial weakness, was apathetic and unco-operative. The decompressed area was markedly sunken (Fig. 4). All the hair of the scalp was absent. There was bilateral optic atrophy. The patient was asthenic, apathetic, and demented. She was discharged Jan. 21. When last seen, on July 8, 1943, her condition was unchanged.

Comment: When the patient first came to the clinic she was thought to have some aphasia but was otherwise mentally quite alert. Now, not only does she again have difficulty with speech, but she is also profoundly demented. This dementia cannot be attributed to an extension of the neoplasm.

CASE V: A woman aged 31 was admitted to the Illinois Neuropsychiatric Institute on July 23, 1941. About four months prior to admission she saw double. The vision of the left eye decreased, and soon that of the right, also. Two weeks before admission, she began to have severe headaches. She had a bilateral papilledema and greatly reduced visual acuity but no definite localizing signs.

On July 26 a ventriculogram was made and on the same day a left parietal osteoplastic exploration was undertaken. No tumor was disclosed but a decompression was done. Recovery was prompt, and x-ray irradiation was begun on the seventeenth postoperative day. A series of 62 roentgen treatments was given from Aug. 12 to Oct. 9, 1941, a total of 15,155 r (air) being equally divided between right and left lateral, vertex, occipital, and frontal portals. Ten-centimeter-square cones were used. The calculated depth dose was 8,693 r. The patient tolerated the treatment fairly well and was discharged on Oct. 10, 1941, feeling well. Her decompression was full but not bulging.

The patient was followed in the out-patient department and remained well and alert, doing her housework, until about August 1943, when she began to complain of lethargy and failing memory. From that time she declined rapidly. She was readmitted on Dec. 9, 1943, at which time she was confused and disoriented and her memory was poor. She was lethargic and responded very inadequately to questions. The hair was absent from the scalp. The decompression was sunken. There were general weakness and emaciation. The tendon reflexes were brisk. The patient was scarcely able to walk, with a hesitant spastic gait.

Pneumoencephalography, Dec. 16, 1943, disclosed slight enlargement of the lateral cerebral ventricles, increase of air over the hemispheres, and slight displacement of the ventricles to the right. The patient was discharged on Dec. 19, 1943. She continued to decline and died on April 26, 1944, at home. There was no necropsy.

Comment: This is another instance of gradual physical and mental deterioration, without increase of intracranial pressure, setting in after months of improvement.

CASE VI: A 12-year-old girl was admitted to the Illinois Neuropsychiatric Institute on May 6, 1941. For three months she had suffered from headache and vomiting. For the last week her vision had failed; her gait was unsteady. She had a bilateral papilledema, nystagmus, inco-ordination of all extremities, and a staggering gait.

A diagnosis of tumor of the cerebellum was made. On May 8, 1941, a suboccipital exploration was done but no tumor was found. Because of difficulty with breathing afterward, due to continued intracranial hypertension, a Frazier needle was inserted into the right lateral ventricle on June 4, and x-ray therapy was begun.

Between June 2 and July 3, 1941, this patient received 9,000 r (air) evenly divided between direct posterior and right and left occipital portals, 10 cm. square. The tumor dose was calculated at 6,150 r. A moderate erythema occurred posterior to the ears, but otherwise the skin tolerated the treatment well. Epilation was complete and permanent.

The patient was discharged on June 23, fairly comfortable, without the ventricular drainage, and irradiation was continued. She remained fairly well except for occasional headache until September 1943, when she had a convulsion followed by fever. The convulsions were repeated, and the patient stated that they were preceded by bright lights in the central visual field. She was readmitted to the hospital on Oct. 18, 1943.

There was no hair over the occiput and suboccipital region. The suboccipital decompression was soft and not bulging. The visual acuity was 15/70, and the visual fields were concentrically constricted. The optic disks showed secondary atrophy but no swelling. There was no nystagmus or other sign of cerebellar dysfunction. The patient seemed somewhat dull and apathetic.

On Oct. 25, 1943, an encephalogram disclosed slight dilatation of the lateral cerebral ventricles, especially the right, and a considerable increase of subarachnoid air over the occipital lobes (Fig. 5). The patient was discharged on Oct. 30. Last seen on July 27, 1944, she had had no more convulsions since taking phenobarbital and her condition was otherwise unchanged.

Comment: The epileptic attacks beginning with visual aura give evidence of irritation of the occipital cortex, and the pneumoencephalogram shows clearly local atrophy. Usually in a pneumoencephalogram, the occipital region has small narrow sulci and is the least well filled of the whole subarachnoid space. In this case, the remainder of the cerebral cortex was not irradiated except as the rays may have come through from the occipital region.

Fig. 5. Case VI. Roentgenogram made after spinal injection of air. Note the unusual accumulation of air in the occipital region.

Five of the six cases here reported showed strikingly similar clinical courses following irradiation. The patients improved and, indeed, appeared quite normal for periods of eight to twenty-six months, perhaps even longer in Case IV. Symptoms then set in pointing to brain damage. These varied from the convulsions and visual disturbances in Case VI to the severe loss of normal cerebration resulting in a vegetative state and death in Cases I, II, and III.

The three highest tumor doses were 8,693, 8,809, and 8,910 r. The patient who received 8,693 r enjoyed twenty-two months of good health from the time irradiation was ended. She died eight months from the onset of symptoms of deterioration. The patients receiving 8,809, and 8,910 r were normal only ten and eight months, respectively, following the completion of irradiation, and died five and four months from the onset of decline.

One patient received 7,758 r in the tumor but failed to return to normal for any appreciable period, passing from the "childishness" caused by the tumor directly into the vegetative state of the radiation degeneration.

Two patients received tumor doses of 6,403 and 6,150 r. The one that received a dose of 6,403 r was an adult. She returned to her normal level of mentality for many months following irradiation, and she was still alive at the end of eighty-nine months. She declined rapidly following her first convulsion and within three months was in a vegetative state. It may be significant that in this case the lateral portals were 10 cm. square but the frontal, vertical, and occipital portals were only 5 cm. square. This spared some of the cerebral tissues from irradiation and reduced the depth dose. This technic was dropped in favor of larger portals when we found at autopsy much more extensive lesions than had been expected on the basis of the operative findings.

It might be suggested that the smaller portals are preferable, since they spare some of the brain tissue from irradiation. Such an argument is not entirely valid, however, when one considers the great length of many of the nerve fibers which course extensively throughout the brain. Lyman *et al.* (43) and Davidoff and his associates (16) found that localized irradiation caused widespread degeneration. This would suggest that the total dosage to the nerve tissue at any one point is the determining factor in causing degeneration. Modifications of the technic are important, therefore, only as they influence the dose

SUMMARY OF AUTHORS' CASES

Case	Age	h.v.l.	r/min.	Portals	No. and Duration of Treatments	Total Dose in Air	Total Tumor Dose	Interval of Health	Interval from End of Treatments to Death
I. Glioblastoma multiforme	44	1.56 mm. Cu	33.5	4	57 105 days	13,000	7,758	None	4.5 mo.
II. Astrocytoma	30	0.75 mm. Cu	50	5	47 84 days	15,120*	8,910	8 mo.	12 mo.
III. Colloid carcinoma	52	0.75 mm. Cu	50	5	49 87 days	14,840	8,809	10 mo.	15 mo.
IV. Astrocytoma	40	1.0 mm. Cu	24	5	51 58 days	15,000	6,403	80 mo. (?)	Alive 89 mo.
V. No tissue obtained	31	0.75 mm. Cu	45	5	62 58 days	15,155	8,693	22 mo.	30 mo.
VI. Medulloblastoma	12	0.75 mm. Cu	49	3	32 32 days	9,000	6,150	26 mo.	Alive 36 mo.

* This patient received, also, 1,995 r (air) over a period of 9 days, elsewhere.

delivered. A discussion of the influence of the rate of administration in roentgens per minute was attempted by O'Connell and Brunschwig (49), but our material is too scanty to warrant evaluation of this factor or the equally important one of the total duration of the series of treatments and its obvious effect on the biological reaction.

The tumor dose in Case IV was at a level which is often stated in the literature to be reasonably safe. It obviously caused profound, though delayed, degeneration.

The patient receiving 6,150 r was a child. She was quite normal for twenty-six months after irradiation and was still alive ten months following her first sign of radiation damage. Her total survival of thirty-six months does not yet exceed the average attained with less intense methods of radiation therapy of cerebellar medulloblastomas. The short interval between her irradiation and symptoms and signs of deterioration could be explained logically on the basis of age, as it is well recognized that the younger brain is more sensitive to radiation. While symptoms of degeneration are as yet limited to the occipital lobes, ultimate widespread changes are likely.

In the cases that came to autopsy, relatively high depth doses had been given. No quantitative variation could be determined in the degenerative changes, and this finding was in accord with the uniform dosage given.

One striking feature was the invariably good state of preservation of the larger blood vessels. This finding is in agreement with the opinion of Brunner (10), O'Connell and Brunschwig (49), Davidoff *et al.* (16), Ellinger (22) and Deery (18) that the vascular effect of the radiation is not the predisposing factor in the deterioration of nerve tissue.

CONCLUSION

Six cases showing definite signs and symptoms of brain damage due to high-voltage roentgen radiation have been presented. Three of the cases came to autopsy and showed extensive degenerative changes in the nerve tissue. One of the cases showed damage with a dose that is often quoted as being safe for brain tissue.

The striking damage to the nerve tissue did not have a counterpart in the vascular structures.

The doses used failed to destroy all of the tumor in any of the autopsied cases of this report, as well as in other unreported cases.

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Roentgen Therapy of Primary Neoplasms of the Brain and Brain Stem

Preliminary Report for the Four-Year Period Jan. 1, 1939–Dec. 31, 1943, with Follow-up as of Sept. 1, 1944[1]

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DURING THE four-year period from Jan. 1, 1939, to Dec. 31, 1943, there were subjected to roentgen irradiation 91 patients with known primary malignant neoplasms of the central nervous system (Table I), as well as an appreciable number of others with neoplasms involving the brain, brain stem, and spinal cord, notably metastases from primary carcinomas of the breast and lung.

TABLE I: PRIMARY NEOPLASMS OF THE CENTRAL NERVOUS SYSTEM IRRADIATED DURING THE PERIOD JAN. 1, 1939, TO DEC. 31, 1943

	Brain and Stem	Cord	Total
Glioblastoma multiforme	29	2	31
Astrocytoma	30	1	31
Astroblastoma	2	0	2
Oligodendroglioma	1	0	1
Oligodendroblastoma	1	0	1
Spongioblastoma	2	0	2
Ependymoma	4	1	5
Medulloblastoma	11	0	11
Neuroepithelioma	0	1	1
Meningeal sarcoma	3	1	4
Chordoma	1	1	2
	84	7	91

This report is restricted to the 80 cases in which histologic diagnosis was possible and in which roentgen treatment was completed on or before the last day of 1943. Four additional cases were under treatment as the period closed, but for statistical purposes these are not included. Of the 80 patients, 6 have been segregated because their irradiation is considered incomplete for any study of its effect, while 14 others have an insufficient follow-up record, and efforts to trace them further in the past two months were fruitless (Table II).

The ultimate classification histopathologically is now under review and will be considered subsequently, in another contribution. This may alter slightly such statistical deductions as will be presented, but it is believed that it will not disturb the general pattern of the series.

TABLE II: PRIMARY NEOPLASMS OF THE CENTRAL NERVOUS SYSTEM IRRADIATED FROM JAN. 1, 1939, TO DEC. 31, 1943: FOLLOW-UP AS OF SEPT. 1, 1944

	Completed Treatment		Incompletely Treated	Untraced	Total
	Known Alive	Known Dead			
Glioblastoma multiforme	5	20	2	2	29
Astrocytoma	15	6	3	6	30
Astroblastoma	1	1	0	0	2
Oligodendroglioma	0	1	0	0	1
Oligodendroblastoma	0	1	0	0	1
Spongioblastoma	0	0	0	2	2
Ependymoma	2	1	0	1	4
Medulloblastoma	4	3	1	3	11
	27	33	6	14	80

Upon the inauguration of a new roentgen therapy section late in 1938, it was agreed that so far as practicable all primary neoplasms of the brain and brain stem showing hope of some improvement or recovery

[1] From the Departments of Radiology (Dr. Peirce and Dr. Tye) and of Neurology and Neurosurgery (Dr. Cone and Dr. Elvidge), Royal Victoria Hospital, Montreal Neurological Institute and the Faculty of Medicine, McGill University, Montreal, Canada. Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

TABLE III: PRIMARY NEOPLASMS OF THE CENTRAL NERVOUS SYSTEM: SURVIVAL IN RELATION TO TUMOR DOSE

	Postoperative-postirradiation Survival	Maximum Dose	Minimum Dose	Average Dose
GLIOBLASTOMA MULTIFORME				
5 patients alive	9–47 mo. Average 25 mo.	15,600 r	6,500 r	9,360 r
20 patients dead	1–64 mo. Average 14.3 mo.	10,560 r	3,980 r	7,390 r
ASTROCYTOMA				
15 patients alive	12–64 mo. Average 45 mo.	19,780 r	4,150 r	8,110 r
6 patients dead	2–44 mo. Average 17 mo.	14,800 r	6,500 r	8,400 r
ASTROBLASTOMA				
1 patient alive	24 mo.	...	...	6,000 r
1 patient dead	6 mo.	...	...	10,200 r
EPENDYMOMA				
2 patients alive	17–40 mo. Average 28.5 mo.	7,300 r	6,880 r	7,090 r
1 patient dead	9 mo.	...	...	8,900 r

would be subjected to irradiation. In the light of the warnings by others relative to the unhappy effect of irradiation upon the brain, for a time a rather conservative program was followed. This consisted in several series of 3,000 to 6,000 r, in air, divided among several ports, at three-month intervals until the desired total was reached. So little constitutional reaction was encountered that we soon determined to proceed on a bolder course, with the result that we now commonly administer total doses of 10,000 to 15,000 r (in air) at 50 cm. F.S.D. with Thoraeus filter, the half-value layer being 2.0 mm. Cu. Filtration of 1.0 mm. Cu and 1.0 mm. Al has been used occasionally.

The tumor dose, calculated by means of observations on a wax phantom, approximated 90 per cent of the total roentgens in air for the frontal lobe lesions, 83 per cent in the temporal and parietal group, and 72 per cent (76.5 per cent for children) in the occipital. These figures are, of course, influenced by the location of the tumor and the number of ports which are practicable.

Initially two fields are each given 100 r per day. If no significant symptoms or signs appear by the end of the first week or ten days, the daily dose is increased to 150 r per field. The scalp will tolerate a considerable amount of radiation suitably filtered and given in consecutive doses. Like other skin areas, it will not tolerate repeated insult at monthly, quarterly, or even yearly intervals, as well as a large dose spread over six weeks. We have had the good fortune not to encounter any serious untoward early or late constitutional effects.

In fact, we have experienced some malicious glee in referring patients who required observation to one of our good friends, so that he might observe not only the apparent effect of the irradiation in control of a tumor, but particularly that he might see the lovely hair which had regrown, following 2,500 r or more to each of four fields. One of the female patients has been especially pleased in that her former ordinary medium-brown hair has regrown in excellent quality, very dark brown, almost black, with a natural curl. Another's mother is quite proud of her daughter's fine blonde hair, which on regrowth retained its former quality and curl. Among the earlier cases, where two or three series were administered, some permanent epilation has ensued.

Mental State: Many of these patients are in a sorry mental state, as well as physical condition, prior to operation. The terrors or violent temper episodes of the patient with a temporal lobe tumor are well known. Others are stuporous to comatose, unmanageable or unco-operative. This disturbed mental state frequently persists postoperatively. Such patients must

TABLE IV: PRIMARY NEOPLASMS OF THE CENTRAL NERVOUS SYSTEM: COMPARATIVE TABULATION OF SURVIVAL PERIODS

	Elvidge, Penfield, and Cone Postoperative	Dyke After operation and irradiation	Present Series After operation and irradiation
Glioblastoma multiforme	8.5 mo.	19.3 mo.	25.0 mo. (alive) 14.3 mo. (dead)
Astrocytoma	36.2 mo.	48.7 mo.	45.0 mo. (alive) 17.0 mo. (dead)
Medulloblastoma	...	22.3 mo.	22.0 mo.

be irradiated with some caution, and, of course, under constant supervision. The improvement which we have observed under treatment in a satisfactory number can hardly be attributed solely to the decompression of the craniotomy and removal of such portion of the tumor as has been possible surgically. The mind clears, coordination returns, and although some aphasia or ataxia remains, as would be expected after the damage of the neoplasm and its partial surgical removal, the mental state of these patients is appreciably to markedly improved. One locally eminent jurist, with an astrocytoma of the left temporal lobe, was able to return to his chambers and adjudicate wisely for some eighteen months following his first two series of irradiation. A business executive, with a right frontal glioblastoma, who had become quite unmanageable, returned to his office in order to arrange his affairs but stayed to manage his business for almost twenty months. A young clergyman, with an astrocytoma of the right frontal lobe, has completed his theological studies at the seminary and has adequately carried on his pastoral duties during the fifty-six months since operation and irradiation. Another clergyman, with a right frontoparietal glioblastoma, was able to return to his parish for most of the thirty-five months which elapsed before his death this past summer.

Tumor Dose: As will be noted in Table III, there is no notable direct relationship between the size of the tumor dose and length of survival. There is some indication that the minimum tumor dose should be greater than 6,000 r for the astrocytoma and 7,500 r for the glioblastoma. The medulloblastomas and ependymomas are insufficient in numbers to warrant any major deductions, save that tumor doses of 6,000 to 7,000 r or more are probably required to affect these neoplasms.

As we have indicated, there is no clinical evidence so far to cause us to hesitate to increase the tumor dose, where possible, to 10,000 or 15,000 r. The limitation will be that of the scalp and possibly the vascular structure of the skull. For the latter reason, we would favor the higher dose in an initial and single series.

Survival Period: Many factors enter into an assay of the results of surgical and radiation therapy of any neoplasm. In malignant tumors of the brain and brain stem, the hazards of the anatomic location and function of the structure involved increase the danger afforded by the type of lesion.

It is to be expected that glioblastoma multiforme will show an almost reciprocally low proportion of survivors as compared with the longevity of a large majority of patients with astrocytomas An appreciable number in either group, and of those with medulloblastoma, will succumb within a few months, in spite of surgical intervention or roentgen therapy. This accounts for the somewhat comparable average length of life for those who died. The high mortality in the first year after diagnosis and surgical intervention, with or without irradiation, is inevitable.

If, on the other hand, the span of comfortable and relatively useful life of the remaining groups can be extended, the effort has been worth while. A tabulation of survival periods in three similar series, relatively comparable save for irradiation, is presented in Table IV.

Surgical removal of the tumor should

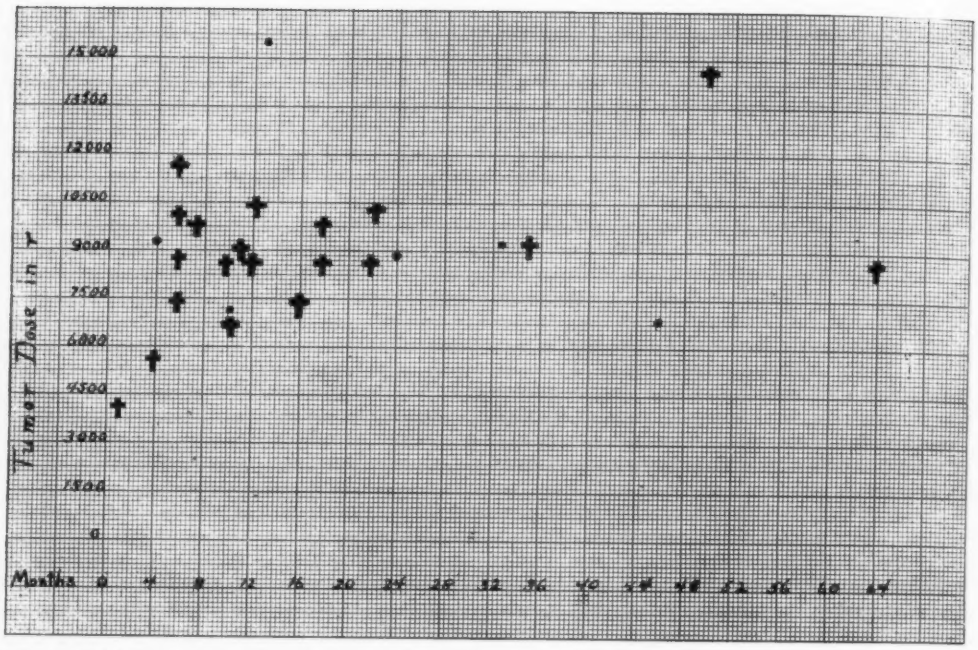

Fig. 1. Glioblastoma: postoperative-postirradiation duration of life, in months. Patients still alive are designated by a dot; those dead by a cross.

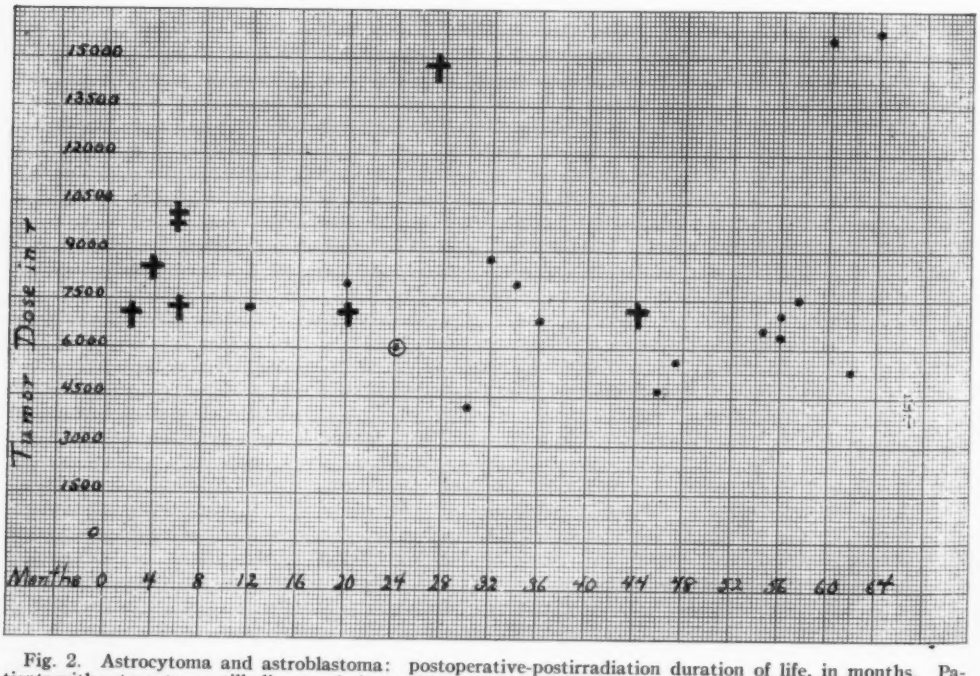

Fig. 2. Astrocytoma and astroblastoma: postoperative-postirradiation duration of life, in months. Patients with astrocytoma still alive are designated by a dot; those dead by a cross. The corresponding symbols for astroblastoma are a dot within a circle and a double cross.

TABLE V: PRIMARY NEOPLASMS OF THE CENTRAL NERVOUS SYSTEM: CLINICAL RESULT AND LONGEVITY FOLLOWING TREATMENT

	Cases	Survival: Postoperative and Postirradiation Maximum	Minimum	Average
(A) Glioblastoma multiforme				
Alive and well	2	47 mo.	9 mo.	23.5 mo.
Alive with residual symptoms	2	...	...	11.0 mo.
Alive with marked symptoms	1	...	...	47.0 mo.
Dead	20	64 mo.	1 mo.	14.3 mo.
(B) ASTROCYTOMA				
Alive and well	12	64 mo.	12 mo.	44.6 mo.
Alive with residual symptoms	3	...	...	46.0 mo.
Dead	6	44 mo.	2 mo.	17.0 mo.
ASTROBLASTOMA				
Alive and moderately well	1	...	...	24.0 mo.
Dead	1	...	...	6.0 mo.
(C) EPENDYMOMA				
Alive and well	2	40 mo.	17 mo.	28.5 mo.
Dead	1	...	...	9.0 mo.
MEDULLOBLASTOMA				
Alive and well	3	40 mo.	12 mo.	29.0 mo.
Alive with residual symptoms	1	...	...	20.0 mo.
Dead	3	7 mo.	6 mo.	6.6 mo.

be accomplished in so far as its nature, location, and extent will permit with safety of the patient. Some will, of course, have residual damage from the tumor—paralyses, aphasia, etc. Patients with no progression of such signs, or improvement, are considered as well as could be expected and, for purposes of tabulation (Table V), are shown among the "alive and well," or "alive and moderately well." These will ultimately show symptoms or signs of further damage or of recurrence. So far, however, we have not detected any secondary degenerative or late effects of irradiation.

We have previously commented on the high mortality early in glioblastoma multiforme, which reaches its peak in the first six to twelve months (Fig. 1). Similar analysis of the survival period of the astrocytomas (Fig. 2) suggests a relatively parallel mortality during the first twenty-four months after operation. Some improvement with the larger roentgen dose is indicated in the survival over thirty-six months. This may be a true shift or simply a variant due to the small statistical sample. We shall not lose hope of improvement, but consider the majority of losses inevitable.

A further analysis of the three series (Table VI) suggests that, with more thorough irradiation, a distinct shift has developed toward longer survival in a higher proportion of the cases, most notable in the periods over fifteen months.

TABLE VI: PRIMARY NEOPLASMS OF THE CENTRAL NERVOUS SYSTEM: COMPARATIVE RESULTS

	Elvidge, Penfield, and Cone (1935)	Dyke and Davidoff (1944)	Peirce, Cone, Elvidge, and Tye (1944)
GLIOBLASTOMA			
Postoperative-post-irradiation survival			
12 mo. or more	31.8%	40.5%	56%
15 mo. or more	13.6%	23.9%	44%
20 mo. or more	9.1%	10%	32%
ASTROCYTOMA			
Postoperative-post-irradiation survival			
12 mo. or more	90.5%	81%	85.7%
24 mo. or more	66.6%	64.3%	71.4%
36 mo. or more	33.3%	38.1%	52.4%
48 mo. or more	14.6%	28.5%	33.3%

Further follow-up and analysis must be accomplished with particular reference to those cases in which death has closed the chapter and gives an absolute line of cleavage from which any major deductions may be made.

SUMMARY

1. Definite clinical improvement is afforded by roentgen therapy of malignant

primary neoplasms of the brain and brain stem.

2. Twenty-five of 60 patients with complete follow-up over the past four years are either "alive and well" or "alive and well save for residual symptoms."

3. No deleterious effects chargeable to the roentgen therapy have been observed in the series. Primary regrowth of hair has been excellent. No late degenerative changes have been observed following total tumor doses of 15,000 r.

4. *Glioblastoma multiforme* continues to show a high mortality rate despite increasingly large doses of roentgen radiation. Probable improvement in longevity is indicated by the analysis of the data. Tumor doses in excess of 7,500 r will be required.

5. The effect on *astrocytoma* is not so marked as would be expected, but this should not discourage treatment similar to that recommended for glioblastoma.

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Neurosurgical Procedures for the Relief of Pain in Advanced Cancer[1]

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RARELY SHOULD a defeatist attitude toward intractable pain be entertained without an investigation of the possibilities of relief by means of surgery. This applies especially to patients with incurable cancer because to them the actual and potential penalties involved are insignificant when compared with the relief of pain which they may expect from surgical treatment.

In this country alone, cancer takes 160,000 lives each year. Of this number of patients passing through the terminal stages of the disease, comparatively few require neurosurgery. Local treatment of the growth, together with other measures such as x-ray therapy and the administration of analgesic drugs, tides the majority of patients over until there are complications causing rapid failure or until cerebral metastases occur which may not only raise the threshold of pain but also make the patient indifferent to his condition.

It is in those patients with intractable pain, whether this comes early or late in the course of a malignant neoplasm, that neurosurgery has a wide field of usefulness. When pain becomes unbearable, relief by surgical means should be considered before allowing the patient to become addicted to opiates. At present, the number of patients being treated in this manner is small, but when the possibilities and advantages of surgery are more widely appreciated, a greater number will be benefited. Opiates may control pain for a brief period, but this interval is shortened as tolerance to the drug is increased. Furthermore, gastro-intestinal disturbances are common and may be as disquieting as the pain itself. The general well-being of patients relieved of pain by surgical means is far better. Often they are able to pursue a gainful occupation for months or years. Moreover, treatment of the formerly painful areas can be pushed to the limit.

CHORDOTOMY AND TRACTOTOMY

Any operation for relief of pain due to cancer should not only produce anesthesia, preferably analgesia, well beyond the limits of the tumor area, but also render insensitive, so far as possible, that part of the body to which pain is apt to spread. For the most part, section of the pain-conducting tracts in the spinal cord (chordotomy) answers these requirements.

For many years, following its introduction by Spiller and Martin (1) in 1912 and subsequent refinement by Frazier, chordotomy was applied only for relief of pain below the diaphragm—mainly in the pelvis and lower extremities. There remained unsolved the problem of pain in the chest, upper extremities, neck, and head, except for such procedures as posterior root section, which left much to be desired.

Stookey (2), in 1931, introduced high cervical chordotomy to raise the level of analgesia to include the upper chest and arm, mainly for the purpose of relieving pain resulting from carcinoma of the breast. In more recent years, other significant contributions have been made. Schwartz and O'Leary (3) and White (4), in 1941, reported sectioning of the spinothalamic tracts in the medulla to relieve pain as high as the neck and posterior scalp.

Schwartz and O'Leary's first patient died two days following operation, but in the meantime satisfactory neurological studies were possible. These revealed

[1] From the Department of Neurological Surgery, University of Virginia Medical School and Hospital. Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

"almost complete analgesia and loss of 'tickling' sensation over the entire lower extremity, with preservation of touch. There was almost complete analgesia over the trunk to the level of the clavicle. There was hypalgesia over the arm and neck up to the left mandible." In another case recorded by Schwartz and O'Leary in which a similar procedure was employed, the patient was relieved of pain in the right chest, shoulder, and axilla, caused by inoperable carcinoma of the breast with metastases, until her death one month later.

White's patient was completely relieved of intractable unilateral neuralgia involving the arm, upper part of the chest, neck, and occiput, but unfortunately she was left with persistent cerebellar ataxia, probably due to injury to the restiform body. This complication, White believes, can be prevented by placing the incision lower in the medulla.

Dogliotti (5), in 1938, published an interesting and perhaps significant report on four cases in which he had sectioned the spinothalamic tracts in the mesencephalon, just above the incisura of the tentorium. His purpose was to make an incision high enough to block all pain impulses from the opposite side of the body, including especially those from the arm, neck, and cervicofacial region. One patient died thirty-six hours after operation. Commenting on the others, Dogliotti stated: "The three other patients all had uneventful postoperative recoveries. These patients during the first three to five postoperative days were quite restless and complained of diffused disagreeable sensations. The preoperative pains disappeared immediately in two patients with a complete secondary hemi-analgesia and were greatly reduced in the other patient."

Walker (6), in addition to duplicating Dogliotti's results, has been able to produce hemi-analgesia in either the upper or lower part of the body by differential section of the spinothalamic tracts in the mesencephalon. Neither mesencephalic nor intramedullary tractotomy has been performed bilaterally.

All of these procedures designed for the purpose of rendering large areas of the body insensitive to pain, and unavoidably thermo-anesthetic, by partial section of the spinal cord, medulla, or mesencephalon, are extremely useful, and each has its indication, depending on the level of analgesia required.

It is seldom that a patient having a malignant tumor below the diaphragm experiences pain sufficiently high to demand anything more than an upper thoracic chordotomy. Therefore, the higher sections, which are more difficult and more dangerous, should be employed only in those cases requiring a high level of analgesia. Upper thoracic chordotomy may be performed bilaterally without danger of disturbing vital functions. This is a decided advantage, as abdominal and pelvic pain rarely remains limited to one side. Seldom, in cases of malignant disease, have we limited the operation to one side. In fact, most of our patients have had spinal metastases or other lesions requiring bilateral chordotomy.

When cervical chordotomy is indicated, it becomes necessary to bring the level of analgesia up to maximum height. This is not always possible, due, in part, to our incomplete understanding of the arrangement of various fibers in the spinothalamic tracts. In fact, the operation must be performed with perfection, and a certain amount of luck, to produce complete analgesia in the chest and upper extremities. It is understandable, therefore, why efforts are being made to develop operations at levels higher than the cervical region. While still in the experimental stage, both intramedullary and mesencephalic tractotomy seem to offer hope for uniformly good results in the upper part of the body.

We have performed cervical chordotomy only unilaterally. It is better to limit the operation to one side, as the incidence of respiratory paralysis is greater when both sides are done at the same time. Stookey (7), who has had considerable experience with this operation, suggests that in cases of bilateral pain operation on the second

side be postponed until after the patient has fully recovered from the first procedure.

ACTUAL AND POTENTIAL PENALTIES OF CHORDOTOMY

Retention of urine, particularly following bilateral chordotomy, is to be expected. Usually, however, normal bladder function returns within a few days to weeks. In some few cases, damage is permanent and a serious urinary problem results. The effect on sexual function is almost constant. Ejaculation is abolished, and, in the female, orgasm is lost.

The close proximity of the pyramidal tracts to the spinothalamic tracts calls for precision in perfoming chordotomy. Fortunately, paralysis of the extremities rarely occurs; weakness, if any, usually is transitory.

A perfect chordotomy is exceptional, although satisfactory relief of pain is to be expected in most cases. In an attempt to prevent loss of motor function, one usually errs on the side of incompleteness. Therefore, it is sometimes necessary to reopen the wound and cut deeper into the cord. When dealing with permanently bedridden patients, one is inclined to be more radical and show less regard for motor function. In this connection, I should like to emphasize the importance of adhering to the same standards of precision in all cases, for if the pyramidal tracts are seriously injured, involuntary mass movements in the affected extremities may become so violent that the beneficial effect of chordotomy is greatly reduced.

During the past three years, 41 chordotomies have been performed on 35 patients by members of the visiting and resident staff of the University of Virginia Hospital. Thirty-three were done on 27 patients with malignant tumors, and in this group there were 2 hospital deaths, giving a 7.4 per cent case and 6 per cent operative mortality. One patient with carcinoma of the lung with extension to the brachial plexus and pleura died suddenly of respiratory paralysis five hours following high unilateral cervical chordotomy. At autopsy nothing was discovered to account for the sudden death. The other patient, who had carcinoma of the pancreas, died of lobar pneumonia three days following bilateral upper thoracic chordotomy.

The mortality from chordotomy, as well as from other neurosurgical procedures for relief of intractable pain, is high but not unreasonably so, considering the unfavorable preoperative conditions that so many of these patients present.

RESULTS OF CHORDOTOMY

The results of chordotomy, particularly upper thoracic, are good. Failures occur, but usually these are due to incomplete section of the spinothalamic tracts. To obtain a better immediate result or to relieve recurrent pain in the area served by chordotomy, we have had to repeat the operation in 18.5 per cent of our cases. The incidence of secondary operations will diminish as we develop a better understanding of the anatomy of the spinal cord. Perfection, however, seems remote, as undoubtedly there do exist individual differences in the arrangement of fibers in the tracts.

THE USE OF ALCOHOL IN THE SPINAL SUBARACHNOID SPACE

The destruction of lumbar nerve roots by the simple method of introducing alcohol into the spinal subarachnoid space has not been widely accepted. As the placement of alcohol is not entirely controllable, the incidence of paralyses, particularly those involving the bladder and rectum, is high. Furthermore, when successful, the injection produces anesthesia in the lower part of the body, which favors the development of decubitus ulcers. Chordotomy is a much better procedure, and it is seldom that it cannot be substituted for the use of alcohol in this manner.

POSTERIOR RHIZOTOMY

Intraspinal section of sensory roots (posterior rhizotomy) is seldom employed except for relief of pain in the chest and neck. In these regions segmental inner-

vation favors the operation, and loss of sensation, in all forms, is not incapacitating. The magnitude of the operation, however, to render large surface areas anesthetic, makes it impracticable. Furthermore, division of numerous radicular vessels may cause serious ischemia of the spinal cord.

Posterior rhizotomy, by removing all forms of sensation, renders an extremity useless. This penalty would be acceptable in certain cases if relief of pain could be assured, but in the experience of many neurosurgeons, including the author, the results have been discouraging. At one time, posterior rhizotomy was extensively employed in an attempt to relieve pain in the swollen, often useless, arm due to carcinoma of the breast. Numerous failures, however, even after section of all sensory roots emerging from the brachial plexus, soon led to interest in the development of more promising procedures, such as high cervical chordotomy and tractotomy.

The pathways through which pain impulses from individual abdominal organs reach the spinal cord are fairly well understood, and these are known to include several posterior roots. Abdominal pain, especially when due to a malignant neoplasm, rarely remains limited to one organ, but spreads to contiguous structures. These may have either a higher or lower segmental innervation, which altogether involves so many nerve roots that relief of pain by rhizotomy is either impossible or impracticable.

SURGERY OF THE CRANIAL NERVES

Pain originating from tumors within the distribution of the trigeminal nerve, *i.e.*, tumors of the mandible, maxilla, tongue, lips, and paranasal sinuses, is completely relieved by the injection of alcohol into one or more branches of this nerve or by intracranial section of the sensory root. Even with moderate extension of the growth beyond this area, interruption of the trigeminal nerve together with the administration of analgesic drugs may be sufficient to insure reasonable comfort for several months. Numbness is the penalty, but this is gladly accepted in lieu of the constant agonizing pain which is so often associated with cancer of the face and mouth.

We have not been confronted with the difficult problem of relieving pain in both sides of the face and mouth. Academic as it may seem, it should be mentioned that both mandibular nerves should never be injected, as paralysis of the muscles of mastication would result. The motor root of the trigeminal nerve accompanies the mandibular branch through the foramen ovale and does not escape destruction when a deep alcohol injection is performed. It is well understood that the loss of one motor root is inconsequential. Relief of pain in both sides of the face and mouth with preservation of mastication is, of course, possible by section of the sensory root of both trigeminal nerves, but the resultant loss of sensation in all modalities would be intolerable.

Alcohol injection of peripheral branches or intracranial division of the sensory root of the trigeminal nerve on one side and section of the descending tract of the trigeminal nerve, as designed by Sjöquist (8), or preferably as modified by Grant (9), to reduce the incidence of hoarseness, on the other side, are logical procedures for the relief of bilateral pain. With sense of touch preserved in one side of the face and mouth, the penalty should not be much more unpleasant than that exacted by operation for unilateral tic douloureux.

Cancer of the face and mouth is well known for its chronicity. After a while, due either to progress of the disease itself or to cicatricial changes resulting from x-ray therapy, pain becomes so widespread that several nerves have to be interrupted in an attempt to bring relief.

Pain usually spreads from the trigeminal area to the posterior part of the tongue and pillars of the tonsils supplied by the glossopharyngeal nerve and to that part of the neck innervated by the upper three or four cervical roots. When confronted with this problem, we have in a few cases sectioned

all of these nerves in a one-stage operation as first proposed by Fay (10). The series is too small for a fair appraisal of the operation. However, encouragement is to be derived from the results in a comparatively large number of cases reported by Grant (11). This, or a similar procedure, employed in 49 cases, gave relief of pain in 80 per cent and partial relief in 12.5 per cent of his cases.

PREFRONTAL LOBOTOMY

One of the most important problems in connection with the management of cancer patients has received little attention from any source and none from the standpoint of surgery which actually possesses a solution. Reference is made to the patient's mental state. Regardless of how stoical a person may seem, he inevitably becomes depressed and anxious when faced with the stark reality of the hopelessness of his condition. To prevent or to relieve this mental state would be to render a service perhaps even greater than the relief of pain itself. Whatever may be the final decision concerning the value of prefrontal lobotomy, it cannot be denied that the operation abolishes worry and fear. Without these, cancer would be of little, if any, concern to its victims. It is predictable, therefore, that prefrontal lobotomy or a similar operation will assume an important role in the treatment of patients with incurable malignant disease.

CONCLUSIONS

The unsolved problems in connection with the transmission and relief of pain are numerous. With the aid of present-day surgical procedures, however, pain caused by known organic disease, such as cancer, can be relieved or greatly diminished in almost all cases. The risk is reasonable, and the penalty is more than acceptable by the unfortunate victim of a malignant tumor.

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DISCUSSION

(Papers by T. J. Wachowski and H. Chenault, Carleton B. Peirce et al., and W. G. Crutchfield)

Merrill C. Sosman, M.D. (Boston, Mass): The juxtaposition of the two papers [by Wachowski and Chenault and by Peirce and his colleagues] on the subject of irradiating brain tumors is indeed fortunate. One is struck, in reviewing the literature, by the high percentage of good or favorable results reported following irradiation. Only occasionally does one find a report of no benefit or actually harmful or deleterious results. The proportion is certainly two to one in favor of irradiation.

But here this afternoon the ratio is one to one. It takes a man like Dr. Bailey[1] to face the facts and assay them with a true investigative attitude of impartiality and to report them with his characteristic fearlessness before this audience. There is no doubt in my mind after this convincing demonstration but that roentgen irradiation delivered in the most approved manner has done extensive and permanent damage to the normal brain tissue. The

[1] Dr. Bailey was associated with Dr. Wachowski and Dr. Chenault in the authorship of their paper, though his name does not appear at its head.

nervous tissue was thought to be quite resistant to x-ray and radium treatments, and any damage which was found was attributed to the effect of irradiation on the small blood vessels and capillaries. Bailey, Wachowski, and Chenault have shown us that the reverse is true.

Dr. Peirce and his colleagues from Montreal have, on the other hand, given us definite and well documented evidence that probable prolongation of life and amelioration of symptoms have followed even larger doses of x-rays to primary tumors of the brain, and they have not observed any of the degenerative or vegetative effects described by Bailey *et al.*

What are we to conclude? Shall we accept these patients for treatment or not? And if we do, how can we best treat them to avoid the deleterious by-products of irradiation?

Analyzing these two papers, I can see only slight differences. Dr. Peirce starts with 100 r at each treatment and, if that is tolerated well, he raises it to 150 r a day to each of two ports, while Dr. Wachowski gives 300 r a day to a single port. Dr. Peirce uses a Thoraeus filter and Drs. Bailey, Wachowski, and Chenault have tried three machines, slightly different in voltage and in copper filter, but I do not believe the marked variation in results reported here is due to that slight difference in technic.

Speaking only for myself, I think we can conclude that a tumor dose anywhere in the brain, of 6,000 r or more, will cause definite damage to normal brain tissue, which may take months or years to reveal itself. But in the presence of an inoperable and irremovable tumor, such as the glioma, that risk is fully justified if amelioration of symptoms or prolongation of life can be expected, since we are dealing with an inevitably fatal disease.

Proceeding to generalizations, the same problem exists in all of our cancer therapy. With surgery becoming more expert and more complete, there are fewer and fewer curable cancers left for the radiologist. The striking exceptions are cancers of the skin, the larynx, and the uterine cervix.

If, then, we can do only palliative radiotherapy in the majority of the remaining cases, we must be sure that we do not make the patient worse in attempting an impossible cure of an incurable lesion. As far as I know, not one case of glioma has ever been cured by irradiation, but many have been improved by doses not exceeding 6,000 r in adults.

Most of you heard Dr. Camp's paper yesterday morning.[2] He told us what happens to the cranial bones twelve to fourteen years after irradiation with much smaller doses. His results were disquieting, to say the least, and each one of us must face the problem of possible late injuries from irradiation, particularly when treating more benign lesions than the gliomata under consideration here.

The same principle of analysis applies to Dr. Crutchfield's report on chordotomy and other surgical methods of relieving intractable pain, particularly in metastatic cancer. Do the end-results justify the time and trouble expended? Do harmful by-products occur often enough to outweigh the usual benefit?

All of us will agree that the results in selected cases of chordotomy or tractotomy do justify the operation and uphold our Hippocratic oath in a true humanitarianism. From the few cases of alcohol injection and posterior root section I have seen, however, those procedures do not seem to be justified by their incomplete or temporary results.

If we cannot cure, we can alleviate. If we cannot either cure or alleviate, then we are working in vain. Above all, we must avoid making these hopeless patients worse.

Vincent W. Archer, M.D. (Charlottesville, Va.): If a personal allusion may be pardoned, I may explain how I first became interested in the relief of pain in advanced cancer. A member of my family, years ago, had an extensive carcinoma of the base of the tongue, with resultant pain such as you are all familiar with. At that time nothing could be done except to use opiates, but though the dosage had been increased to huge proportions at the time of my relative's death, the pain could not be wholly controlled. Unfortunately he lingered on for about a year. So I have been personally much interested in doing something for these poor unfortunates.

The actual discussion of Dr. Crutchfield's paper is logically opened by reiterating his first sentence: "Rarely should a defeatist attitude toward intractable pain be entertained without an investigation of the possibilities of relief by means of surgery."

Where does the radiologist fit into this picture? He has been what may be called a road block on the path to the end that so many of these cancer patients envision. If the proper physician-patient relationship exists, the radiologist has the confidence of the patient. Therefore, when the pain grows unbearable, it is the radiologist whom the patient consults—the man who has treated him.

The radiologist naturally sees more cancer patients than any other one man among the group with whom he is working, because the majority of them come to him at some time. Therefore, he can get a pretty good idea of what goes on and what may be accomplished. He can do much toward promoting the proper use of neurosurgery in the relief of intractable pain in advanced cancer. There are, of course, certain painful lesions which can be treated more successfully by other methods. Each case must be evaluated individually. Patients with carcinoma of the prostate should certainly have the advantage of an orchiectomy. The relief of pain following this procedure is dramatic in many instances, while the melting away of hyperplastic new bone formation is familiar to all of us who have followed the results of the operation. Carcinoma of the breast that has metastasized to bone, with very painful

[2] See page 213.

areas, should unquestionably receive radiation therapy because of the striking response so often obtained, with relief of pain and even bone regeneration. The same is true of many other far advanced malignant growths. Each case must be individualized. Just because the patient has pain does not mean that he is a candidate for neurosurgery.

For patients who are not amenable to radiation or other less drastic forms of treatment than neurosurgery, the latter procedure should be considered. The general surgeon or radiologist should not take it upon himself to pick and choose the cases that should have this type of treatment. He should have the advice of a competent neurosurgeon.

Though Dr. Crutchfield did not make the statement in his paper, he has said that he is afraid he appeared a bit too pessimistic. I take issue with him on this point, for he is adopting the surgeon's point of view that if you fail to get a complete cure the operation has not been successful. On the other hand, if you can reduce a grade 4 pain to a grade 1 pain, you make life far easier for the patient.

Dr. Crutchfield spoke about the untoward by-products of neurosurgery—the loss of sphincteric control and the paralysis of the extremities that sometimes occurs. When you see these patients writhing with pain, except for the shortening intervals when they are under narcotics, and then see them lying fairly comfortably in bed, even with a lack of sphincteric control, you feel that they have made a pretty good swap. Their expected span of life is not long and, even with such so-called bad results, relief for six weeks or two months makes the last mile a bit more tolerable.

I think that Dr. Crutchfield has done a lot for the patients on whom he has operated in our clinic in this matter of pain relief. I do not believe that the mortality incident to neurosurgical procedures thus used should enter into the picture at all, for the patients are already near the end.

Percival Bailey, M.D. (Chicago, Ill): I do not agree with Dr. Sosman that the score this afternoon regarding x-ray treatment of brain tumors is one to one. I did not say that x-ray treatment of brain tumors does not produce improvement, nor do I believe it. In all of the cases that we showed this afternoon, very definite improvement followed x-ray treatment—in one instance for as long as six years before the inevitable decline set in. X-ray treatment *does* produce improvement in cases of brain tumor. I am quite convinced of that. But I am also thoroughly convinced that you can't get any better results with 15,000 r than you can with 5,000 r and that you may produce irreparable damage to the brain.

It is difficult to discuss critically a paper like that of Dr. Peirce without having all the data at hand. Merely looking at figures doesn't get one very far. I am not convinced that any of his patients with medulloblastoma had their length of life increased beyond that which could be obtained by 5,000 r, nor am I convinced at all by his figures that his astrocytoma patients had their lives prolonged even by treatment with 15,000 r. The astrocytoma is a very long-lived tumor. I have known patients to live fifteen or twenty years postoperatively.

Now to produce a degeneration of the brain in trying to cure glioblastoma multiforme may be justifiable. When you see a big glioblastoma that you know is going to kill the patient in a few months and realize that there is no other hope for him, you can give him as much x-ray radiation as his skin and underlying tissues will tolerate; prevent him from getting a big, unsightly hernia, and produce a frontal lobotomy without having to resort to surgery. I have done that intentionally. You destroy the frontal lobes of the brain and the patients do not worry, they do not have any fear, do not have big unsightly hernias, and do not suffer from headache. Altogether it's a good thing, in such cases, to produce a degeneration of the brain.

An astrocytoma, however, is an entirely different matter. I do not believe it is justifiable to give 15,000 r in such cases and risk producing a degeneration of the brain which may not come on for at least six years after cessation of the treatment.

Dr. Peirce states that in none of his cases was a degeneration of the brain provoked. It is impossible for me to judge the accuracy of that statement without all the clinical records available for study. On the basis of my own experience I believe it to be very probably incorrect.

Commander C. B. Peirce (*closing*): Dr. Bailey, of course, is maintaining a very consistent attitude. We accept his challenge.

I would call attention to the fact that of the four cases which have been analyzed histologically by him, the average length of life was fifteen months. For our patients who are now dead, average duration of life was 14.3 months for those with glioblastoma and 17 months for those with astrocytoma. There is a definite loss ratio in the glioblastoma and the astrocytoma group, no matter what is done, with surgery, with irradiation, or with neither.

It is our feeling that the case is not closed; that it warrants further study.

Further, on the basis of our experience, we feel definitely that more conservative initial irradiation is advisable. In that regard, too, I would call attention to the fact that in irradiation of any lesion we must avoid damage to surrounding and overlying normal tissue to the maximum degree, save in so far as is necessary to produce an effect on the tumor.

Consequently, my feeling is that higher filtration, fractionation within moderate limits so as to confine the complete course within forty-two to forty-nine days, and the avoidance of large fields or any more fields than are necessary for adequate irradiation of the tumor and its environment, are advisable.

The Roentgen Appearance of Lobar and Segmental Collapse of the Lung

V. Collapse of the Right Middle Lobe[1]

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Boston, Mass.

COLLAPSE OF THE right middle lobe of the lung occurs frequently, and is still confused with interlobar effusion (1). The location of the middle lobe, between the greater and the lesser fissures of the right lung, explains the original mistaken roentgenologic interpretation of these two processes. On the roentgenogram, the pulmonary fissures appearing as lines, or septa (4, II), are now recognized as boundaries of the various lobes. The minor septum and approximately the lower half of the right major septum bound the middle lobe. In collapse of this lobe the septa tend to come closer together as the lobe decreases in size, and the final shadow of increased density may simulate that of interlobar effusion which would, if present, lie in the same plane. The shape of the shadow cast by interlobar effusion, however, is different, and very rarely is a proved case seen without fluid elsewhere in the pleural cavity. At the present time, the diagnosis of collapse of the middle lobe can be made accurately if certain definite characteristic signs are looked for, and if their importance is recognized.

Collapse of the right middle lobe, or of one of its segments, occurred in 26 per cent of the group of 600 cases of collapse studied. It is our purpose to discuss in detail the roentgenologic appearance of the pulmonary abnormalities which distinguish collapse of the middle lobe, or of its segments, and the most satisfactory means of demonstrating them.

The middle lobe lies in the antero-inferior portion of the right chest, making up essentially all of the pulmonary tissue adjoining the right border of the heart as seen on the roentgenogram. It is demarcated by two septa, the minor running more or less horizontally and the major running downward and anteriorly, as previously described (4, II). The bronchus to the right middle lobe arises from the right main bronchus at the level of the origin of the bronchus to the dorsal division of the right lower lobe. The middle lobe bronchus immediately divides into two branches, the anteromedial, which supplies the segment of the lobe adjoining the right border of the heart, and the posterolateral, which supplies the segment lying adjacent to the upper lobe and the anterolateral chest wall.

Complete obstruction of the bronchus to the right middle lobe causes the lobe to decrease markedly in size, and roentgenologically to assume a somewhat pyramidal shape with its base against the right border of the heart and its apex extending toward the lateral chest wall. Since the general plane of the middle lobe is more or less oblique, running from the hilus anteriorly and inferiorly to the lower fourth of the anterior chest wall, the ordinary postero-anterior roentgenogram does not catch it entirely in profile, and thus the fact that it is the site of a disease process may not become apparent until some other abnormality is observed—that is, loss of definition of the right border of the heart. Since almost all of the lung immediately adjacent to the right border of the heart consists of right middle lobe, any interference with its aeration will produce loss in definition of this border. This is true both of atelectasis and of collapse due to obstruction caused by a foreign body or tumor, or to pneumonic consolidation.

Another factor which somewhat obscures the actual condition of the middle lobe

[1] From the Department of Radiology, Massachusetts General Hospital, Boston, 14. One of a series of papers accepted for publication in October 1944.

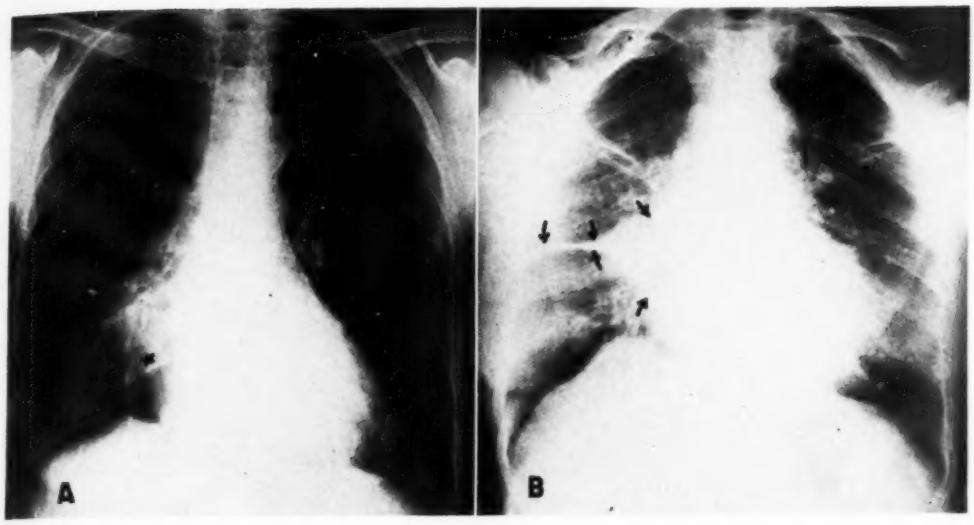

Fig. 1. Collapse of the entire right middle lobe. A. The shadow of increased density represents the collapsed lobe, which obscures the right border of the heart. B. The *Kreutzhohlstellung* projection more clearly defines the collapsed lobe. See also Figure 1C.

on the postero-anterior roentgenogram is that at least two-thirds of the inferior portion of the right chest is occupied by the lower lobe. Normal aeration of the lower lobe, therefore, permits fairly good radiance of the lower lung field even in the presence of atelectasis or collapse of the middle lobe.

The importance of the lateral roentgenogram in all forms of collapse has been stressed previously; in examination of the right middle lobe, it is the most essential single factor in the examination (3). In this projection, the middle lobe, when entirely collapsed, is represented by a band of increased density, varying in thickness from several millimeters to 2 or 3 cm., located in the plane of the antero-inferior portion of the major septum. The widest portion of the shadow always lies against the anterior chest wall or the diaphragm. The upper portion of the shadow diminishes in width until it forms an apex at the junction of the major and minor septa. The shadow of collapse is frequently interpreted as a collection of fluid or exudate, since it gives the impression that it follows the plane of the greater fissure. Actually it can be differentiated from interlobar effusion

Fig. 1C. Collapse of the entire right middle lobe. The arrows indicate the margin of the collapsed lobe. The dense white line represents its lateral portion as it is superimposed on the bulk of the middle lobe shadow. Bronchoscopy showed the middle lobe orifice to be narrowed and completely blocked by thick secretion. Bronchiectasis of the collapsed right middle lobe was demonstrated by bronchography.

by the shape of the shadow of increased density. In the case of collapse of the middle lobe, this shadow is somewhat triangular and includes the shadows of the major and minor septa; in interlobar ef-

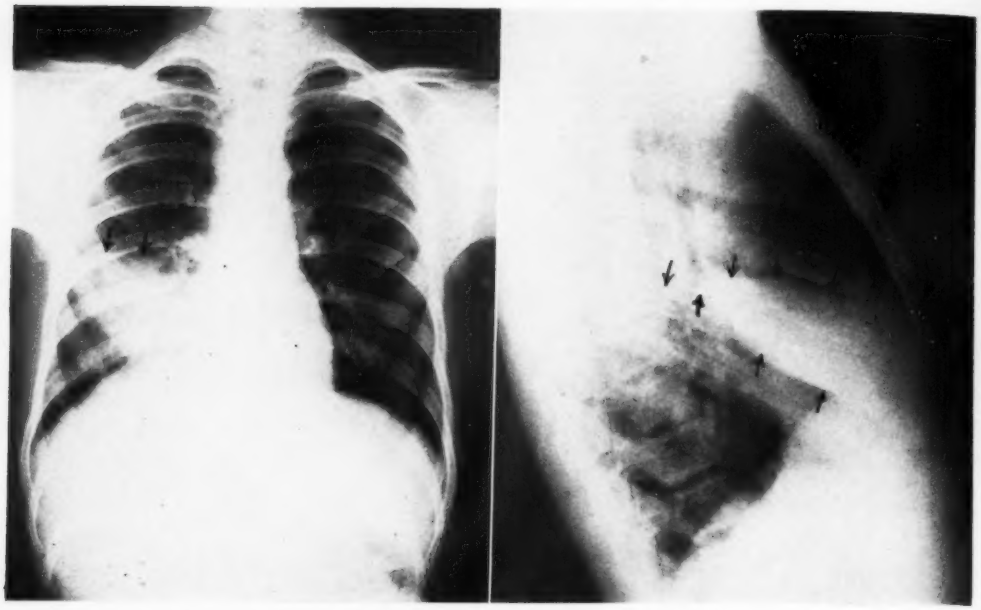

Fig. 2. Partial collapse of the entire right middle lobe. The middle lobe is only moderately decreased in size. The shadow of increased density is larger than that usually seen because the amount of collapse is not great. Shadows similar to this are sometimes confused with those due to interlobar effusion.
Right middle lobectomy. At operation the middle lobe was found to be collapsed and indurated.
Histopathology: Bronchiectatic abscess: acute and chronic pneumonitis.

fusion it is ovoid or elliptical and at least portions of the septa will usually be visible and in normal position.

The definition of the shadow of increased density caused by collapse of the middle lobe can generally be enhanced by use of the lordotic position (Kreutzhohlstellung) (2). In this view, it stands out because the greater portion of the lobe is more nearly parallel to the central ray and the bulk of the lobe is shown in profile. Observation of the middle lobe in this projection is easily accomplished during routine fluoroscopy and should be made more frequently.

The hilus is seldom, if ever, depressed as the direct result of collapse of the right middle lobe. The antero-inferior portions of both the upper and lower lobes tend to come together as the middle lobe contracts and thus occupy the space formerly filled by it. Since normally the middle lobe fills a relatively smaller portion of the chest than the other lobes, no striking emphysema is demonstrable as a rule, nor are the heart and mediastinum often displaced appreciably to the right. Since almost all of the diaphragm is outlined by the aerated lower lobe, collapse of the middle lobe does not usually interfere with its demonstration.

Segmental collapse of the right middle lobe was seen more frequently than complete collapse. The lobe has two main segments, the anteromedial and the posterolateral. The former is more often involved in collapse than the latter. Collapse of the anteromedial segment is difficult to differentiate from collapse of the entire lobe, since in both instances the outline of the right border of the heart is at least partially obscured. Only by careful scrutiny of the shape and location of the shadow of increased density, and the observation that the minor septum is still demonstrable in a relatively normal position, can it be determined that collapse is confined to the anteromedial segment. In the postero-anterior roentgenogram the shadow of increased density appears directly in apposition with the right heart

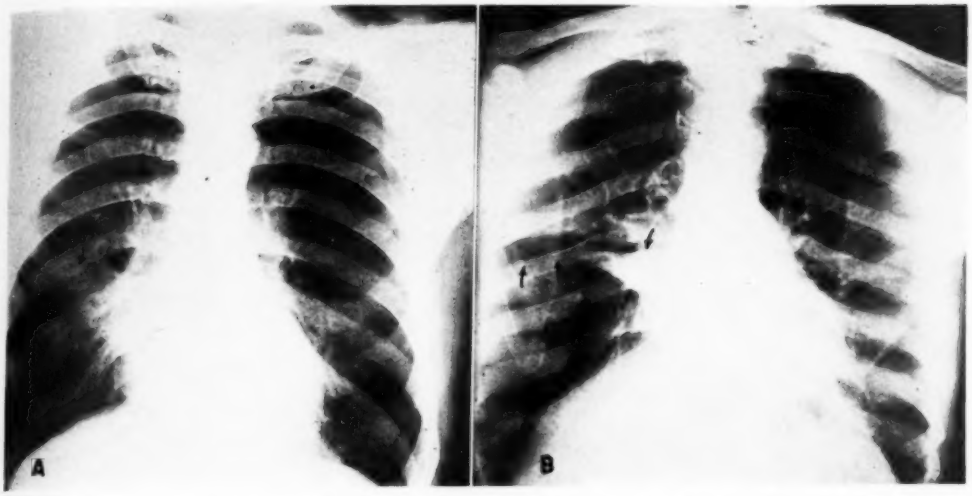

Fig. 3. Collapse of the anteromedial segment of the right middle lobe. A. A collapsed anteromedial segment produces a shadow of increased density which obscures the right border of the heart. The arrow indicates the visible portion of the minor septum adjacent to the aerated posterolateral segment of the middle lobe. B. The *Kreuzhohlstellung* projection shows that the shadow of density does not extend to the lateral chest wall as in collapse of an entire middle lobe. The lateral portion of the minor septum is visible. See also Figure 3C.

border and does not extend laterally as far as that of the entire lobe. In the lateral projection, the shadow tends to lie more anteriorly and inferiorly than in collapse of the entire lobe (Fig. 3). If, on the other hand, the posterolateral segment only is involved, the definition of the right border of the heart, in the postero-anterior roentgenogram, will remain sharply defined, as the area of density is located farther laterally. In the lateral view, the shadow of increased density is in the posterior portion of the area ordinarily occupied by the middle lobe. The portions of the major and minor septa adjacent to this shadow are lost, but the remaining portions are clearly visible, indicating that the anteromedial segment is aerated (Fig. 4).

Collapse of the right middle lobe associated with collapse of the right lower lobe, due to bronchial obstruction, may be difficult to identify, as the combined shadow of increased density is quite characteristic of collapse of a lower lobe alone. A differential feature, however, is that in collapse of the two lobes it will be impossible on any roentgen projection to demonstrate the minor septum.

Fig. 3C. Collapse of the anteromedial segment of the right middle lobe. The arrows indicate the location and shape of the collapsed anteromedial segment. Bronchoscopy did not reveal the cause of collapse.

Although this discussion has dealt primarily with the right middle lobe, in general what has been said applies to a great extent to collapse of the lingula on the left. In position, the right middle lobe and the

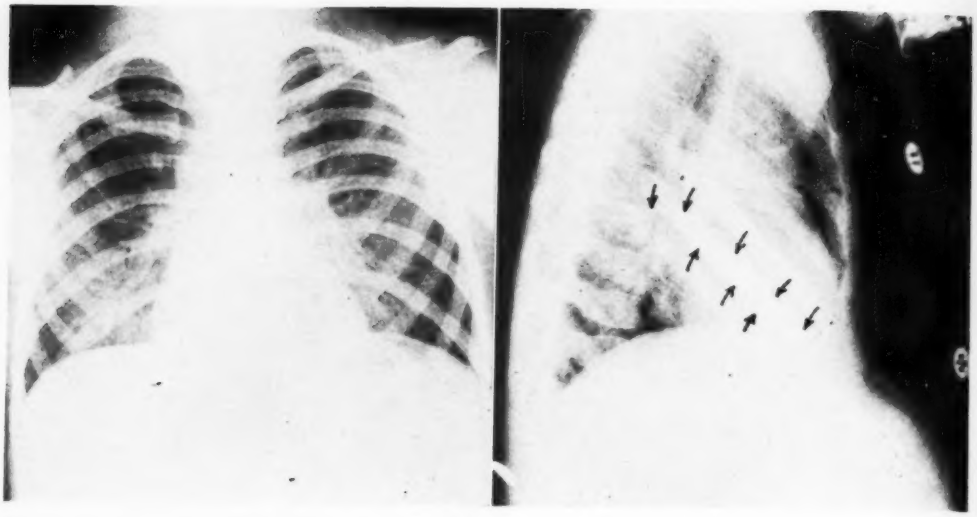

Fig. 4. Collapse of the posterolateral segment of the right middle lobe. In the postero-anterior projection, the right border of the heart is sharply defined but the shadow of increased density is barely recognizable. In the lateral view, the shadow of density, outlined by arrows, represents the collapsed posterolateral segment. There is incidental collapse of the dorsal division of the lower lobe. Bronchoscopy failed to reveal the cause of collapse.

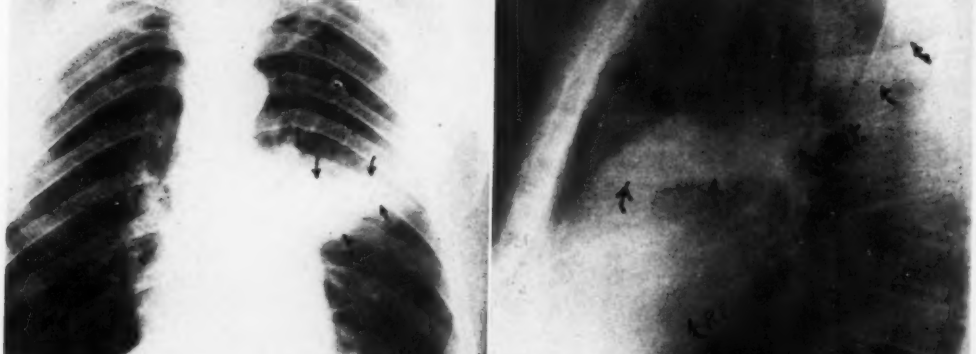

Fig. 5. Collapse of the lingula of the left upper lobe. In the postero-anterior projection the shadow of increased density is outlined by arrows. It is slightly higher than is usually seen in collapse of the entire lingula, but it obscures a portion of the left heart border. In the lateral view, the shadow of density lies in the anterior portion of the chest, superimposed upon the upper part of the heart shadow. The position of the major septum of each lung is clearly demonstrated.

Left upper lobectomy. Grossly the specimen showed collapse of the lingula and some involvement of the axillary segment.

Histopathology: Epidermoid carcinoma, grade II.

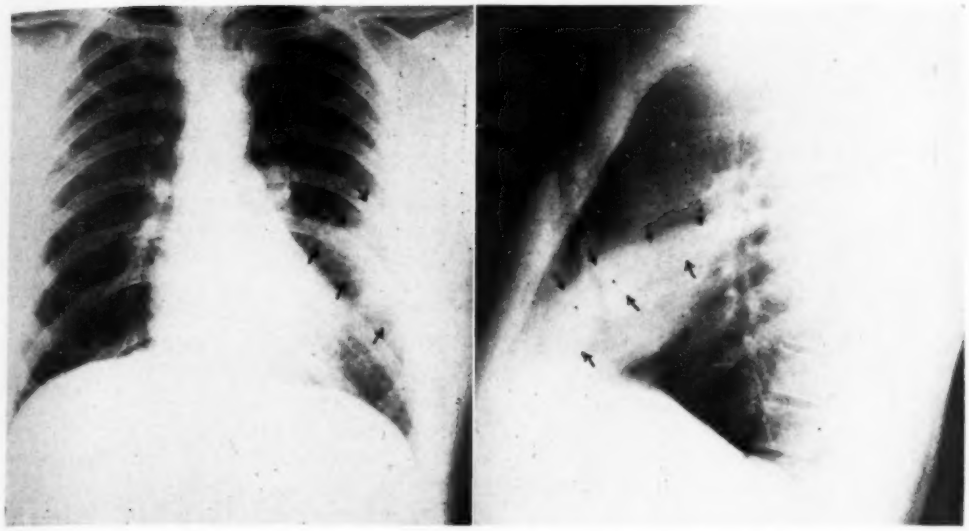

Fig. 6. Collapse of the anterolateral segment of the lingula of the left upper lobe. In the postero-anterior projection the shadow of increased density lies laterally and the left border of the heart is sharply defined. In the lateral view, the shadow of density is seen in the position usually occupied by the anterolateral segment of the lingula (arrows). The posterior margin of the shadow indicates the position of the major septum of the left lung. The asterisk indicates the position of the major septum of the right lung.

lingula of the left upper lobe are analogous. Anatomically, they differ in that the one is a separate lobe and the other is not, and in the origin and distribution of their bronchial supply. The lingular bronchus arises from the proximal portion of the left upper lobe bronchus and divides into two branches supplying the anterolateral and the posteromedial segments of the lingula. Bronchiectasis often causes collapse in the lingula of the left upper lobe associated with similar involvement in the lower lobe, but it is not readily recognized without bronchography. This is due to the fact that the collapsed lingula moves posteriorly and becomes confluent with the shadow of the collapsed lower lobe.

Approximately 20 cases in our series have been interpreted as isolated collapse of the lingula, but in general they are insufficiently proved to make detailed description of their roentgen appearance worth while. Briefly, in the lateral roentgenogram, the shadow of collapse of the lingula is much like that of the right middle lobe. It lies in much the same location and its configuration is similar. In the postero-anterior view, it lies close to the heart and tends to obliterate or blur the left border (Fig. 5).

A certain number of cases in which segmental collapse of the lingula was believed to be present have been seen. This is not as easily identified as segmental collapse of the right middle lobe because of the absence of a minor septum on the left side. The anterolateral segment has been more often involved than the posteromedial. In the postero-anterior roentgenogram, the shadow of a collapsed anterolateral segment lies close to the lateral chest wall and does not obliterate the left border of the heart; in the lateral projection, it lies against the septum (Fig. 6). A few cases have been seen in which the posteromedial segment was believed to be collapsed, and in them the shadow of increased density was similar to that caused by collapse of the entire lingula, except that it was smaller and its lateral portion was aerated.

CONCLUSIONS

Collapse of the right middle lobe should not be confused with interlobar effusion.

Collapse of the middle lobe is recognized by the size, shape, and location of the shadow of increased density, which usually obscures the right border of the heart.

Collapse of the lingula of the left upper lobe is similar to collapse of the right middle lobe in certain respects.

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Intestinal Obstruction: Further Experiences in the Use of Flat Abdominal Films[1]

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IN 1937 WE REPORTED a series of cases of intestinal obstruction diagnosed with the aid of flat films of the abdomen. The experience gained in the first series proved of considerable value in estimating the significance of a distended abdomen, and we have continued our study for the past seven years. While we have nothing startling to report, we feel that certain impressions and experiences should be recorded.

Perhaps a few statements should be made as to the findings which enable one to make a diagnosis of mechanical obstruction by the use of flat films. A gas bubble is normally present in the stomach, and gas in varying amounts in the colon. The small bowel, on the other hand, shows little or no gas when normal peristaltic movements are present. In the presence of abnormal stasis, however, gas begins to collect proximal to the point of stasis and quickly becomes visible on the roentgen film. Gas in the colon normally is derived from small bowel contents. When these contents fail to reach the large bowel in sufficient amounts, the colon gas is diminished and in severe cases disappears. These are the physiological facts upon which is based the roentgenographic diagnosis of obstruction. The roentgenologist, therefore, when confronted by a film, must determine:

(1) Is there gas in the intestinal tract?
(2) Is it in the colon or in the small bowel or both?
(3) If in both, what is the relative amount in each?

With these three questions answered, a diagnosis can readily be made and a shrewd guess can be hazarded as to the location of the obstruction.

The real problem lies in the second question, as the utmost care may at times be necessary to differentiate between small and large bowel. Since this differentiation is all-important for a diagnosis, considerable effort and study should be devoted to its accomplishment. We have found that a repeat examination, sometimes within an hour, is the greatest single aid in solving this problem. Certainly, we must admit, cases are encountered in which it is extremely difficult to distinguish between the distended Kerkring folds of the small bowel and the normal haustral markings of the large bowel.

Occasionally one is satisfied that gas is present in both the small and large bowel. This could be due to a reflex paralytic ileus from shock, as from renal colic, to gastrointestinal pneumatosis, peritonitis, or partial mechanical intestinal obstruction. If treatment is to be instituted at a favorable time, differentiation of these conditions is of prime importance. It can be made only after careful study and repeated examinations. One must determine whether the small bowel is distended more than the large bowel. If both are equally distended (not necessarily to the same size; it is a question of percentages), paralytic ileus is considered first. If the small bowel attains the size of the colon in the film, partial mechanical obstruction is diagnosed. The whole problem resolves itself into a comparison of the size of the gas collections in the small and large bowel, keeping in mind the normal size of each. We have always felt a little uneasy as to our diagnostic criteria in cases where enemas had been given recently. It seemed logical to suppose that an enema could remove the gas from the colon in a case of peritonitis or paralytic ileus and thus lead to a diagnosis

[1] Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–2, 1943.

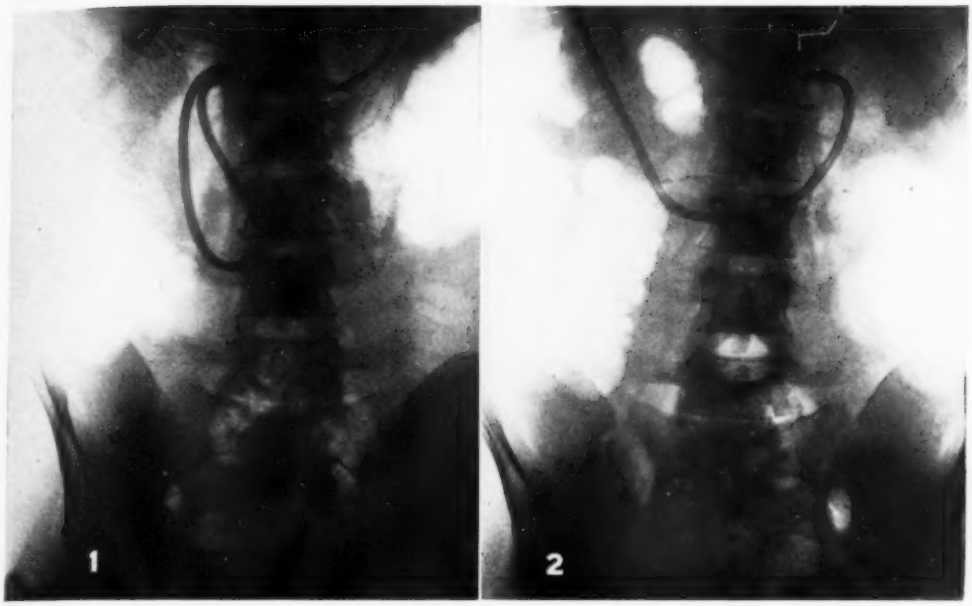
of mechanical obstruction of the small bowel based on the presence of small bowel gas, which is always present in paralytic ileus. We are now convinced that an enema does not remove the gas from the ascending colon in the presence of paralytic ileus, so that an erroneous diagnosis of small bowel obstruction need not be made. The gas in the cecum and ascending colon is enough to rule out such a diagnosis.

With the introduction of the Miller-Abbott tube and Wangensteen decompression, there followed a radical change in the attitude of the physician toward mechanical intestinal obstruction. Many surgeons and internists have come to regard intestinal obstruction as no longer an emergency. Too frequently the instruction is given: "Just pass the Miller-Abbott tube and we'll study that patient again in the morning." Our experience does not justify this attitude. Several of the fatal results in the present series of cases could be attributed directly to the use of the Miller-Abbott tube, that is to say to its *abuse*, not its correct use. Time and again the Miller-Abbott tube is confidently passed by an intern, only to have the x-ray on the following morning show it in the stomach, or at most in the duodenum. The internist—and many times the surgeon—will then make a strenuous effort to pass the tube further along and will order another x-ray study the next day. This time, the tube is perhaps found a little further on, or it may be merely curled up in the stomach. Frequently the stomach and the upper jejunum have been relieved during this forty-eight-hour test period, but the obstruction is still present and the coils of the distal bowel are still distended. Actually, because the proximal gas has been relieved, the abdomen may show slightly less distention and the patient may feel a little better. Thus another day may be taken up with inadequate drainage, and an operation is finally attempted, at the insistence of the x-ray department, only after a lapse of seventy-two hours. It is this type of case that has raised the mortality figures in our present series. At the end of seventy-two hours of improper drainage, gangrene of the bowel is not infrequently found, with the usual disastrous result. We know that it is entirely unfair to judge the Miller-Abbott tube on the basis of such cases, but in our experience the patient has fared better with early operation—as soon as the diagnosis of obstruction was made—than with the ineffective use of tube drainage and observation. We feel that the general surgeon, without special training in the use of the tube, is likely to abuse this method of treatment to the detriment of the patient. Our present series numbers 65 cases. We have chosen a few representative ones to illustrate some of the problems in the care of intestinal obstruction. The first is the type of case which we call "Miller-Abbott tube neglect."

CASE I (Figs. 1 and 2): The patient was admitted to the hospital on March 4, 1944, complaining of cramp-like pains in the abdomen for the past three days. For one week preceding admission, she had had an acute vaginal discharge associated with pain in the lower abdomen. An appendectomy had been performed seven years previously.

The patient was acutely ill. The abdomen was rigid and moderately distended, and there was tenderness in both lower quadrants. A diagnosis of gonococcal salpingitis was made by the clinician. For the next six days the patient was treated conservatively for pelvic peritonitis. Surgical consultants concurred in this diagnosis, and operation was considered unnecessary and undesirable at this time.

The x-ray examination was done six days after admission. Flat films were first made, leading to a diagnosis of mechanical obstruction of the small bowel, based on small bowel distention and lack of gas in the colon. A Miller-Abbott tube was then passed for the first time, and conservative treatment started in deference to the x-ray report. The surgeon, however, was not convinced and still considered peritonitis the more likely diagnosis. There was slight improvement, and on further surgical consultations, operation was deemed unnecessary. The next day another x-ray examination was made, again leading to a diagnosis of intestinal obstruction. The findings, however, were not completely conclusive, so that after three hours examination was repeated. This time intestinal obstruction was diagnosed without qualification. We considered obstruction complete and urged immediate surgery, in spite of the apparent slight improvement in the patient's condition. Surgery was not considered necessary by the clinician, however, and twenty-four



Figs. 1 and 2. Case I. In Figure 1 the Miller-Abbott tube is in place but has not left the stomach. There is some small bowel distention resulting from intestinal obstruction. Figure 2 shows the tube still in the stomach on the next day. The small bowel distention is worse. The surgeon was still not convinced.

hours later a further x-ray examination showed complete obstruction.

The surgeon, finally persuaded to operate, found complete obstruction of the small bowel with multiple perforations and gangrene. A resection was done. Convalescence was stormy but, with the aid of sulfa drugs, the patient recovered.

Comment: The diagnosis in this case was clouded by the clinical picture of acute salpingitis. The Miller-Abbott tube apparently stopped the vomiting, giving a false impression of improvement. The surgeon, though well trained, was not fully aware of the value of flat films in such a case and delayed operation for a whole week. We have learned to regard x-ray examination in such cases as a very important procedure for determining the need for surgery. In this connection, it should be noted that, despite the slight improvement in the patient's general condition at one time, the nurse consistently reported "no gas" returning from the rectal tube. Stethoscopic examination of the abdomen also was inconclusive, so that, while we recommend such examinations, we have not found them very trustworthy. Another significant finding in this case was that, in spite of the many days of use, the Miller-Abbott tube never passed beyond the duodenal curve. Use of the tube made for a feeling of false security and led astray the clinician as well as the surgeon.

A second type of case which deserves some comment is "postoperative convalescent obstruction." We do not have in mind here the distention and distress occurring several days or so after what appears to be an uneventful postoperative convalescence. Such a case is under immediate suspicion for mechanical obstruction. We have reference particularly to the patient who has had a fairly stormy course for three days, with evidence of peritonitis, and then feels better, only to show distention again about the tenth day. Frequently there is no appreciable recovery from the initial peritoneal irritation, but distention appears almost continuous from the first day. This case is the one that so frequently has been diagnosed as peritoni-

Fig. 3. Case II. Postoperative convalescent obstruction. The tube is coiled in the stomach. Small bowel distention indicates mechanical obstruction. The surgeon refused to recognize the necessity for further operative procedure and the patient expired during an operation which was undertaken too late.

tis and paralytic ileus. The condition may be neglected for days unless tube drainage is successful in holding the distention in check. Time and again we have pleaded with the surgeon for proper x-ray examination, and time and again the answer has been: "What's the use? The portable film is unsatisfactory and the patient is too sick to be moved. Besides, we have already passed the Miller-Abbott tube. Let's wait; what can the x-ray do for peritonitis?" While we are quite aware that tube drainage may be of tremendous value in just this type of case, it has rarely been successful in our hands. We repeat that this is not the fault of the tube. We feel it is our inability to pass it properly and quickly. It is not unlikely that this is the experience in many other general hospitals.

Quite aside from the use or abuse of the Miller-Abbott tube in this type of case, there is still another obstacle that the ordinary surgeon has been unable to overcome; that is the problem of moving the sick patient to the x-ray department for an adequate x-ray examination. Some of these patients are not suffering from paralytic ileus. Their distention is due to a mechanical obstruction. Operation is essential. If a diagnosis is not too long delayed, cure is easy and mortality is practically nil. We believe that moving the patient to the Bucky table is no real hardship, that it is without danger and will frequently reward the surgeon with a quick, accurate diagnosis as to the type of distention which is present. We can see no harm in lifting the patient carefully onto a cart and then onto the x-ray table. In this connection, it must be mentioned that occasionally the stationary Lysholm grid has given us portable films adequate for a diagnosis. A typical case of postoperative convalescent obstruction follows:

CASE II (Fig. 3): The patient was admitted to the hospital on May 25, 1941, complaining of abdominal cramps accompanied by menstrual disturbances and a vaginal discharge. A diagnosis of bilateral salpingitis was made, and twenty-four hours later a laparotomy was performed. Both tubes, the fundus of the uterus, and the left ovary were removed, together with the appendix. The convalescence was a little stormy, and four days after operation the patient began to show some distention. In an effort to relieve this, a Levine tube was passed. At this time, a diagnosis of peritonitis was made.

On the eighth postoperative day, an x-ray examination was finally made, and a diagnosis of mechanical obstruction of the small bowel was reported. The tube was shown to be in the stomach. A second examination was made one hour later, again indicating mechanical obstruction, and operation was urged. The attending physician still could not be aroused. Surgical consultation was called the following day, and a diagnosis of mechanical obstruction with peritonitis as a result of rupture was made. The surgeon advised immediate operation. A perforated bowel was found, markedly distended as a result of a mechanical obstruction. An ileostomy was done, but the patient died the same day.

Comment: Here is a case of a mechanical obstruction developing in the postoperative convalescent period, with treatment for peritonitis for eight days before an x-ray examination was even ordered. In addition, the operation was delayed twenty-four hours after an x-ray diagnosis was made, because the surgeon was not convinced that mechanical obstruction was present. We feel reasonably certain that if an x-ray examination had been ordered

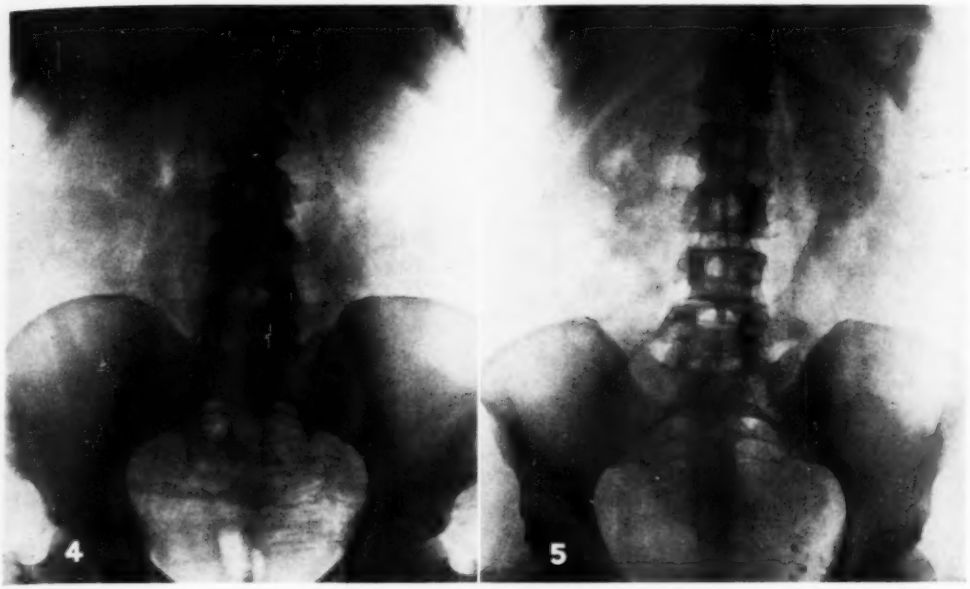


Fig. 4. Case III. "No gas" intestinal obstruction. Abdomen flat in this case, probably because of the high obstruction found at operation. Immediate relief following surgery.

Fig. 5. Case IV. The pre-x-ray diagnosis was urinary colic. X-ray showed no stones. There were minimal amounts of gas in the small bowel and none in the large bowel. A diagnosis of intestinal obstruction was made with some hesitation. Further clinical examination showed a small incarcerated femoral hernia. Operation brought about immediate relief.

on the fifth day, as soon as distention was observed, a diagnosis of mechanical obstruction followed by operation would have saved this patient's life.

Perhaps the most intriguing case that has come to our attention is the one we call the "no gas" obstruction case. Here we have reference to the film which shows no gas in the colon and practically none in the small bowel; at least, the small bowel gas is well hidden and seen only on very close inspection. Absence of gas in the colon immediately puts a case under suspicion of mechanical small bowel obstruction. This is logical, on the theory that colon gas is derived from the small intestine contents. This, however, is only half of the story. For a conclusive diagnosis, at least in the past, we have demanded the presence of small bowel gas in addition to diminution or absence of gas in the large bowel. Such cases are relatively easy to diagnose. When the small bowel distention is not seen, one is inclined to interpret the findings as normal. The absence of colon gas is then accounted for by supposed rigorous and successful cleansing enemas and physics. This group of findings has been a source of considerable anxiety to us. Frequently we have been forced to go into the clinical history for aid. It is helpful to know (1) whether there have been many successful enemas and the type of return; (2) whether bowel movements have occurred; (3) whether intestinal obstruction is suspected.

Cases III, IV, and V are examples of "no gas" intestinal obstruction.

CASE III (Fig. 4): The patient was admitted for the first time on May 28, 1942, complaining of pain in the abdomen and bloating. She vomited several times and the bowels would not move without an enema. She was nauseated and could not eat or drink. This condition had been present for forty-eight hours. There was a history of cesarean section four years before and a hysterectomy two years later. Physical examination showed two operative scars and a relatively flat, soft abdomen with tenderness

in the lower left quadrant. The patient remained in the hospital two days and was discharged as improved, with a diagnosis of fecal impaction. No films were taken at this first admission.

The next day the patient returned, feeling worse. At this time films of the abdomen showed no appreciable gas in the small or large bowel. This absence of colon gas, in spite of the lack of visible small bowel distention, was considered significant, and a diagnosis of mechanical obstruction in the small bowel was made. At operation a band of adhesions was found, completely obstructing the jejunum. The colon was collapsed, as was a good portion of the ileum. Recovery was uneventful.

Comment: Fortunately a resection was not necessary in this case. If films had been made at the first admission, several days of obstruction might have been eliminated. The relatively flat abdomen was probably due to the high obstruction.

CASE IV (Fig. 5): The patient was admitted July 24, 1943, and discharged Aug. 2, 1943. The complaint was severe pain in the abdomen; no vomiting. There had been no previous surgery. The bowels had always been regular until the present illness, which was of only forty-eight hours' duration.

Examination showed a good general appearance, dry tongue, and distended rigid abdomen. Tenderness was present over all the abdomen. The attending physician suspected renal colic, but an x-ray film of the urinary tract showed no stones. There was practically no gas in the colon, and very small collections of gas were scattered through the small bowel. A diagnosis of mechanical obstruction in the ileum was made. In the absence of a previous history of operation, we urged the attending physician to look again for a hernia. A small incarcerated femoral hernia was then discovered. Operation showed marked dilatation of the small bowel up to the incarcerated loop in the hernia. The patient made a good recovery.

Comment: Here again the absence of gas in the colon pointed to the correct diagnosis even though the condition had been missed by the attending physician. In these cases it must be stated that, unless obstruction is previously suspected, the film is likely not to arouse suspicion. Actually the diagnosis of obstruction in this instance was not made immediately by the x-ray department. It was made only on the next day, and then with considerable hesitation. Every once in a while a film of the urinary tract is encountered showing little or no gas in the colon. It would be entirely impractical to diagnose mechanical obstruction in all such cases. Clinical symptoms must be checked, and progress films must prove the lack of gas to be constant. It is likely that some patients may normally have only small amounts of gas in the colon. It is also possible that the patient may have been examined just after a good bowel movement, or several successful enemas may have been given. All these factors must be determined before a diagnosis of mechanical obstruction can be based on "no gas" in the bowel. Seldom, however, have we been able to influence appreciably the amount of gas in the ascending colon by ordinary enema.

CASE V (Fig. 6): The patient was admitted Jan. 14, 1941, and discharged Feb. 1, 1941. For the previous two days, she had been complaining of abdominal cramps and repeated vomiting. The past history showed an appendectomy.

The patient was acutely ill and in great pain. The abdomen was soft and not distended. A diagnosis of food poisoning was made. Medical consultation the next day suggested acute pancreatitis. Transfusion was ordered. X-ray examination was done at this time to rule out obstruction. Films taken thirty hours after admission showed no colon gas and small amounts (negligible, as in the usual abdominal examination) in the small bowel. An x-ray diagnosis of small bowel mechanical obstruction was made, but the attending clinician was not convinced.

At surgical consultation, two days later, mechanical obstruction was first considered, and then paralytic ileus. All this time the Levine tube had been in place. An operation was finally done on the third day, and intestinal obstruction was found. A large segment of the ileum was hemorrhagic. There was much bloody fluid in the peritoneal cavity. A dense adhesion was cut. No resection was necessary. The patient recovered nicely.

Comment: The absence of gas in the films (Fig. 6) was striking, but the clinician could not be convinced in view of the lack of abdominal distention on admission. Much of the diffuse shadow in the abdomen is probably due to the bloody fluid in the peritoneal cavity, but this fluid could not obstruct a view of gas collections if they had been appreciable. Could fluid within the distended loops obscure the gas shadow in the films? In our previous series of intestinal obstruction, we showed that large amounts of fluid in the small bowel

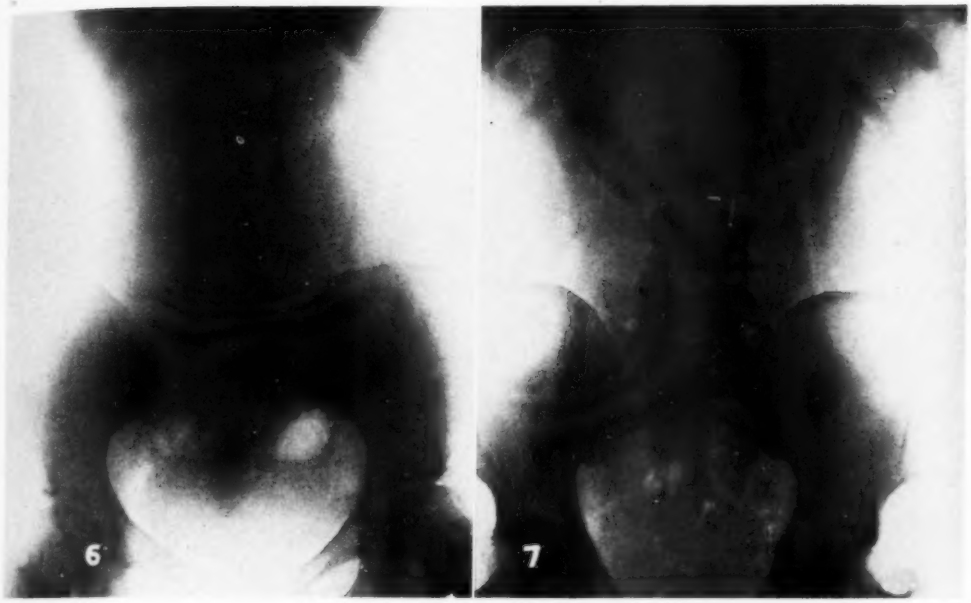


Fig. 6. Case V. "No gas" in abdomen. No x-ray examination for first thirty hours. Clinical diagnosis was food poisoning. Surgery delayed for two days even after x-ray diagnosis of obstruction. At operation, a band of adhesions was cut successfully. The fluid in and around the coils in the intestines may be the cause of the x-ray finding of "no gas."

Fig. 7. Case VI. History of previous ulcer led the clinician to make a diagnosis of impending rupture of ulcer. No x-ray examination for three days. The film shows a "no gas" intestinal obstruction. Operation performed immediately after x-ray diagnosis. The patient expired, delay in x-ray examination being an important contributing factor.

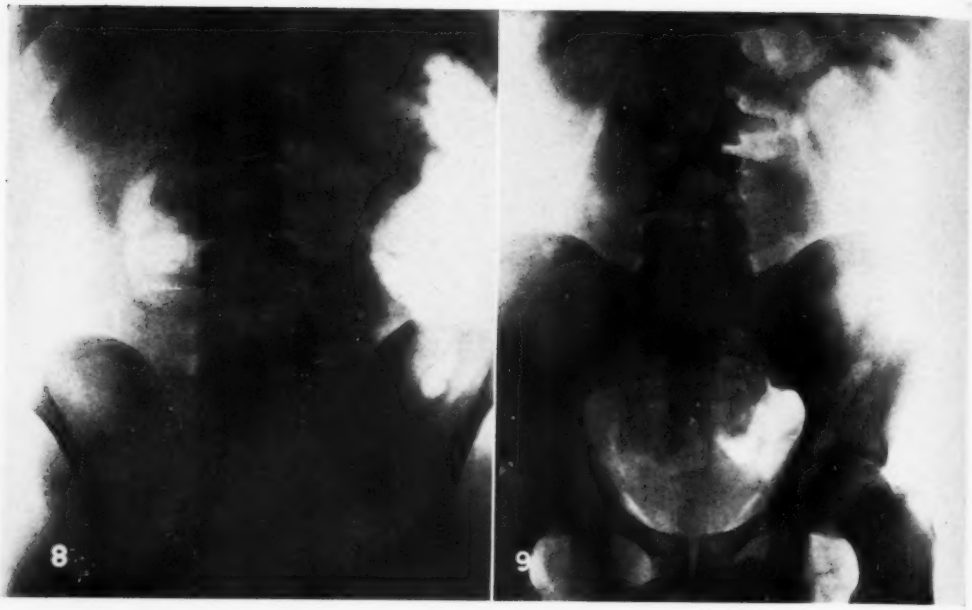
can, under certain conditions, completely obscure the gas in the distended bowel.

Although this group of cases is called "no gas" obstruction, the classification is not literal. At first glance there appears to be little or no gas; on close inspection a single distended loop of small bowel is usually seen.

Many clinicians at our hospital are fully aware of the usefulness of scout films of the abdomen in acute abdominal cases. Others, however, are still unaware of the occasional striking value of such films. Case VI is a typical example of an acute abdominal condition where earlier x-ray examination might have helped.

CASE VI (Fig. 7): The patient was admitted to the hospital on March 18, 1944, and died three days later. At the time of admission he was complaining of epigastric pain, vomiting, and some distention of the abdomen, extending over a period of six days. In 1943 he had had a peptic ulcer, which had perforated. The physical examination showed slight distention of the abdomen. Films taken March 21, three days after admission, showed no significant lesion in the stomach (a diagnosis of perforating ulcer had been made by the clinician). Flat films were taken and a diagnosis of mechanical obstruction of the small bowel was made. Surgery was immediately performed. The patient went into collapse on the operating table and died three hours later.

Comment: Here is a case of mechanical obstruction diagnosed from flat films, but a delay of three days before x-ray examination was ordered cost the patient his life. The films showed little or no gas in the small or large bowel. In spite of the great amount of attention the x-ray department has given to these cases, many general practitioners are still unaware of the advantages of flat films in acute abdominal cases. A history of a previous perforating peptic ulcer misled the clinician, so that intestinal obstruction was not seriously considered until three days later.



Figs. 8 and 9. Case VII. Figure 8, a postero-anterior view, shows moderate distention of the small bowel. Diagnosis is intestinal obstruction. In Figure 9, an anteroposterior view, the small bowel gas is hidden sufficiently so that a diagnosis would be difficult. These two films demonstrate the necessity of multiple views.

Fig. 10. Case VIII. Gas in small bowel and some in large bowel. No distention in any loops. X-ray diagnosis was "no obstruction." Surgeon disagreed and operated for obstruction. Postoperative course proved this case one of herpes zoster and justified the x-ray diagnosis.

CASE VII (Figs. 8 and 9): The patient was admitted to the hospital May 12, 1943, and was discharged as improved on May 30, 1943. He had been complaining of pain in the right lower abdomen for forty-eight hours, accompanied by nausea and vomiting. He had previously undergone an appendectomy and an operation for a femoral hernia.

Physical examination showed a tender abdomen with swelling in the right lower quadrant and enlargement of the scrotum, suggesting an incarcerated hernia. A flat film of the abdomen, taken on the day of admission, showed little or no gas in either the small or large bowel. This led to the diagnosis of intestinal obstruction, and an operation was immediately done. A band of adhesions was found, constricting the small bowel at the ileocecal valve. The hernia was not the cause of the obstruction. Recovery was uneventful.

Comment: Close collaboration between the clinician and x-ray department in this case led to a prompt diagnosis of intestinal obstruction, and surgery freed the devitalized loops of bowel, as shown in the films.

We have not always been convinced of the correctness of our interpretations. Frequently we have had to hedge and wait forrepeated examinations in cases which

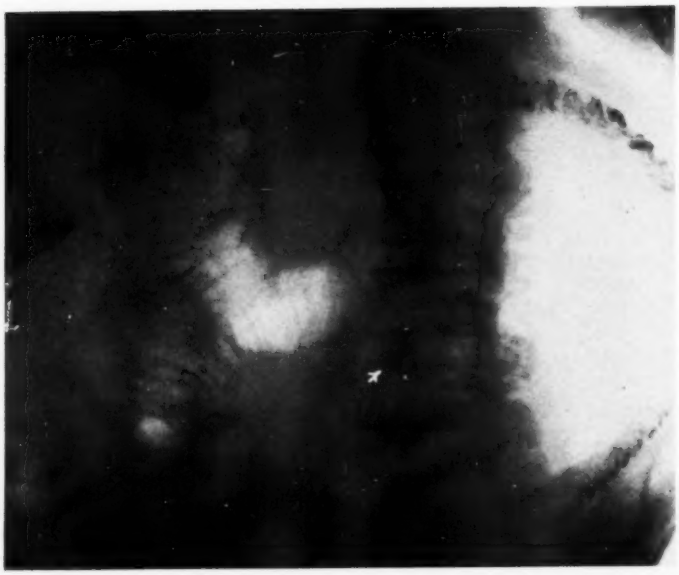


Fig. 11. Case of intestinal obstruction. Note relative size of distended small bowel and collapsed large bowel.

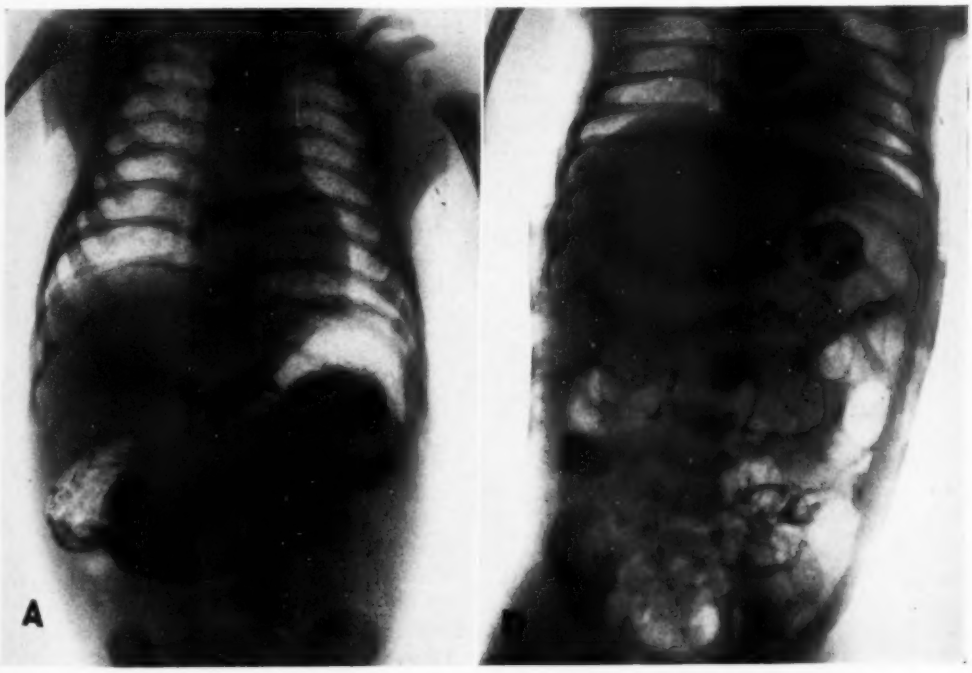


Fig. 12. A. Congenital hypertrophic pyloric stenosis, before operation. No gas in the small bowel. In the infant small bowel gas is normal. Its absence means an obstruction at the pylorus. B. Same case immediately after successful operation. Normal small bowel gas content.

Fig. 13. Note gas in small and large bowel. No relative distention of either is seen. Distal colon gas was removed by cleansing enema. This is a case of urinary colic (see arrows).

Fig. 14. At first glance there appears to be little or no gas in the abdomen. If obstruction was clinically in question, this film could be, on superficial examination, corroborative. On close examination the patch of gas seen is large bowel, so that obstruction is ruled out. Cleansing enemas and physics occasionally cause some diagnostic problems if obstruction is also suspected.

finally proved to be intestinal obstructions. Not once in this series, however, have we made a diagnosis of intestinal obstruction and been proved wrong. We present here a case which at first seemed to represent a diagnostic error. Postoperative findings showed the true diagnosis.

CASE VIII (Fig. 10): The patient entered the hospital complaining of acute attacks of cramp-like pain in the right upper abdomen, radiating to the back. Constipation was habitual and the patient had always taken laxatives. There was no vomiting. An operation for the removal of a bladder stone had been done some eight years earlier.

Physical examination showed a distended abdomen with extreme tenderness in the gallbladder region. A diagnosis of cholelithiasis was made. An x-ray examination indicated no mechanical obstruction, normal kidneys, no calcified gallstones. The surgical consultant, however, advised operation for intestinal obstruction, and reported finding a band of adhesions around the sigmoid sufficient to have caused the abdominal cramps and a partial obstruction. Surgery had apparently been justified. We reviewed the films and again could not make a diagnosis of mechanical obstruction. We recorded this as an error against the x-ray department.

Several days after discharge, the patient reported vesicles developing in the right upper quadrant and, on re-examination, the obvious diagnosis of herpes zoster was made.

Comment: With due respect to the surgeon, we believe that the pain in the right upper quadrant and the entire right side of the abdomen was due to the developing herpes zoster and that the band of adhesions found near the sigmoid was probably not of any clinical significance from the point of view of obstruction.

CONCLUSIONS

In corroboration of our previous experiences, we present our further findings:

1. In our hands, the use of the Miller-Abbott tube was, as a rule, unsuccessful. In some cases it needlessly delayed operation, giving rise to fatalities. It frequently gives a false sense of security.

2. We urge immediate operation in all cases of mechanical obstruction. Our best

Fig. 15. Urinary colic. A. Gas in large bowel, before cleansing enema. B. Same case after cleansing enema. Only distal colon gas is removed in these reflex ileus cases.

results were obtained where no reliance was placed on the Miller-Abbott tube.

3. We feel, nevertheless, that the Miller-Abbott tube does have distinct value and may sometimes be life-saving where operation is contraindicated and in some cases of postoperative distention.

4. We urge accurate x-ray study of all cases of postoperative distention after the third day, to help differentiate between peritonitis and mechanical obstruction. We feel that such patients, even though very sick, should be moved to the x-ray department for proper and dependable films. Only in this way can we make an early diagnosis of "postoperative convalescent obstruction."

5. Examples of the "no gas" case of obstruction have been described. These caused us considerable difficulty in diagnosis. Repeated examinations cleared up the diagnosis in practically every case.

6. The roentgenologist can and must assume greater responsibility in determining the need for surgical intervention in these cases.

7. A Miller-Abbott tube or a Levine tube will frequently stop vomiting, giving a false impression of improvement. We now depend considerably on the x-ray films for determining the cause of the distended abdomen. The frequency of vomiting and the rectal passage of small stools are important but not conclusive.

8. Flat films of the abdomen in acute abdominal cases will frequently reveal the correct diagnosis.

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Radiology of the Chest: Its Evaluation in the Prevention of Tuberculosis[1]

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THE DISEASE

TUBERCULOSIS is an infectious disease which, for its transmission, necessitates contact by a susceptible patient with infectious material. Some persons appear to be naturally susceptible; in certain cases susceptibility appears as a familial tendency: the children of infectious persons, being constantly exposed to infection, frequently fall victims to it. There is evidence that we in Great Britain have acquired considerable resistance to the disease but that this resistance can be broken down by debilitating influences such as lack of necessary foodstuffs, sunshine, and open air, by constant fatigue, overcrowding and bad ventilation, by damp and cold, and by illnesses, particularly those associated with respiratory infections or fibrosis.

Public health measures aimed at isolating and educating the infected and remedying the defects mentioned above resulted in a steady decline in the incidence of tuberculosis, and there is every reason to believe that more enthusiastic and consistent work along these lines would cause a considerable further reduction. In the early years of the war, when its restrictions, impositions, and black-out conditions forced the population to share these debilitating influences with a large number of infectious persons (estimated as at least 50,000) who were deprived of medical aid because of the shortage of doctors, we saw a definite increase in the number of cases of tuberculosis.

Like all other infectious diseases, tuberculosis has an incubation period which is followed by an onset with definite clinical signs and symptoms. These vary according to the susceptibility of the patient and the virulence of the infection. In some cases the gravity of the disease becomes apparent soon after the onset; at the other end of the scale are those patients who exhibit signs and symptoms of a relatively mild respiratory disorder which are mistaken at first for those of a cold, or influenza, and, if they continue, of bronchitis. The majority of these milder cases terminate in complete recovery; we only know of their existence because we find evidence of old healed lesions. Some cases, however, show but temporary recovery, lasting for a variable time, from a few months to ten or more years, after which a recurrence of activity of the disease develops; the symptoms of such recurrences vary in severity and call for treatment accordingly. The gradual development of a chronic inflammatory condition of the lungs with its bouts of quiescence and activity may not attract attention to the gravity of the disorder. During quiescence the patient may feel quite able to work and enjoy a certain amount of leisure over a period of twenty to thirty years or more, and neither he nor his doctor may suspect the true nature of the disease. But for its infectious nature and the possibility of others acquiring it, tuberculosis for the greater period of its duration may not present the distressing symptoms of such pulmonary conditions as silicosis, bronchiectasis, and asthma.

Diagnosis of infective cases can be established by examination of the sputum, but of late years the spectacular demonstration of tuberculosis by radiography has led doctors to consider the latter as a means of early diagnosis. How has this been brought about?

RADIOLOGY

With the discovery of x-rays by Roentgen, in 1895, began the attempts to demonstrate tuberculous foci in the lungs.

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In the early years, because of the necessarily long exposures during which it was impossible to keep the patient or his lungs sufficiently stationary, only the grosser lesions could be detected. Gradually the time of exposure was progressively reduced by the introduction of units having a greater output of x-rays and the manufacture of faster and faster films and intensifying screens. The quality of the radiographs was also improved by perfecting the control and output of the tube and reduction of its focal point, as well as by employing emulsions on film and screen of the finest grain. These factors permitted the radiologist to produce radiographs which showed the more minute detail of all structures having contrast density. But this detail was not understood, and, as in so many spheres into which radiology has been introduced, bold interpretations were advanced before the normal and its variations had become known. The vascular pattern of the lung, for instance, with its infinite variety, was frequently and still is interpreted as hilar tuberculosis with peribronchial spread. Such errors could not escape the attention of able physicians, who were thus taught to distrust radiographic interpretation.

Gradually, however, the work of reliable radiologists has convinced the physician that radiology can make important contributions toward the elucidation of clinical problems. Today, with good technic, it is possible to produce radiographs showing typical appearances for many conditions, including tuberculosis—so typical that even the novice with average intelligence can readily be taught to recognize them at a glance. It is perhaps this ready recognition which is really responsible for many misinterpretations, because, having acquired this superficial knowledge so readily, the novice is apt to assume the cloak of competence and seek little further for learning. Without experience, he fails to appreciate the full significance of the following: (1) that artefacts on the films have appearances which may simulate pathological lesions; (2) that the radiograph is a measure of the relative densities of all the structures between the x-ray tube and the film, including all the material or tissue on the skin of either side of the area covered and all structures within; (3) that certain protuberant structures, as the nipples, breasts, male generative organs, warts, muscle folds, etc., when pressed against the film, screen that part of it with which they are in close contact from the secondary radiation that fogs the adjacent film, and thereby produce a transparency which, in contrast to its surroundings, suggests an increased density and may be interpreted as a foreign body within; (4) that all the structures of the area covered by the film, no matter how far they may be separated anatomically, are brought together in the plane of the film into one conglomerate mass which presents a kaleidoscopic variation of appearances, not only as the result of disease in any of the tissues but, what is perhaps still more important to realise, even under normal conditions; (5) that the lesions in each disease have many different appearances and yet many diseases may at one stage show appearances which are indistinguishable from one another; (6) that a lesion must have acquired a certain size or produced a relative contrast density in the adjacent tissues before it can be visualised radiographically, so that there is an early stage in all lesions in which the radiograph is of no value; (7) that in disease the radiographic evidence lags behind the clinical symptoms and signs, and this applies at the beginning as well as in the convalescent stages.

Failure to appreciate these features, particularly when associated with inadequate clinical investigation, is responsible for dangers to the patient which are more real than apparent. I have known the chest to be repeatedly needled for pus because the radiograph showed a spindle-shaped opacity on the lateral wall of the thorax, due to projection of the opacity of the biceps (the radiograph having been taken with the arm against the patient's side) over the chest wall. Operative meas-

ures have even been performed or lengthy investigations made to seek information as to the nature of an artefact on a film and to explore the normal and its variations, which were not known. On the other hand, neglect has followed the mistake of interpreting the appearance of pathological conditions as that of normal structures.

Obviously, therefore, it is the duty of any medical practitioner who wishes to take the responsibility of interpreting radiographs to acquire the knowledge which would preclude the errors mentioned above. He is held responsible in the courts in certain cases if he fails to have a radiograph taken. Is he not even more responsible if he attempts to interpret radiographs of which he has little or no knowledge? We as radiologists are in some measure to blame for the present state of things. We have paid more attention to spectacular demonstration of radiographic appearances than to a careful study of just what those appearances have meant. The film has been the attractive feature rather than the report. Most of our contributions to the literature and to society meetings have been devoted to a demonstration of what the radiograph can show, and there has been far too little attention or emphasis on the fact that there are many more conditions of which the radiograph will not give the slightest indication. Because of this, clinicians have come to depend upon the radiograph for help in all cases and they are so disappointed when they receive negative reports in the presence of marked clinical signs and symptoms that they tend, sometimes with no reason whatever, to attribute the failure of radiographic contribution to the poorness of the radiographs or the incompetence of the radiologist. No wonder they are tempted to do their own radiology. To this there can be no objection, providing they expend every reasonable effort to study all the factors concerned with the production of the radiograph and its interpretation, and to keep abreast with all the advances in radiology. But to do this, they must become radiologists, for those of us who devote our whole time to radiological study have problems every day which we find difficulty in solving. In the solution of these we often obtain the best help from the physician who has made a careful study of the clinical aspects of the case; without this study we should be deprived of help and the solution would escape us.

There is probably no branch of medicine or surgery where co-operation between clinician and radiologist is productive of so much good work for the patient or where failure to co-operate can lead to so much error in judgment and treatment as in tuberculosis. Neglect in either specialty tends to lead one or the other to seek his own facts in a sphere in which he is not experienced. To do this, he frequently neglects to obtain the best from his own particular specialty, with the result that he can make little or no useful contribution and his judgment suffers.

The reason why cases of tuberculosis are missed is that no attempt has been made to exclude the possibility of its occurrence by examination of the sputum for the bacillus or by radiography of the chest. Either or both of these may give positive evidence or such as will keep the case under suspicion. In some instances the sputum provides the evidence before the lesions have acquired a size or density permitting radiographic demonstration. An even greater number of lesions will not be recognisable on the fluorescent screen. The clinical signs and symptoms may be recognised by the experienced physician at a time when radiographic appearances are normal, *i.e.*, the radiographic evidence lags behind the clinical. In some cases the patient is so susceptible that the clinical signs are rapidly followed by extensive radiographic signs, so extensive that some clinicians have erroneously regarded this as evidence that the disease was missed because it was previously symptomless and no radiograph was taken. Even in the less susceptible patient, if the clinician persists in his suspicion and has a fur-

ther radiograph taken after an interval of time, depending upon the degree of susceptibility and upon the virulence of the organism, roentgen evidence will be forthcoming in the positive case. Failure to seek this radiographic confirmation followed by temporary or permanent improvement in the general condition will result in failure to diagnose the disease. The patient may now unsuspectingly become a chronic carrier.

Since tuberculosis is an infectious disease having an incubation period and a further period which may be without radiographic evidence, we must, if we are to use radiology as a preventive measure, ask for early roentgen examination of all persons showing signs or symptoms of chest disease and sequestrate those with negative findings until, after an interval of say three months, a repetition of the examination confirms the earlier observation. In addition, we must repeatedly examine all those persons who are known to have been in contact with the disease. Those who are found to be infective must be segregated or at least taught how to avoid infecting others. The latter would appear to be the only course available and it must obviously depend upon the goodwill and determination of each patient. This in itself is a demand unlikely to be met in all cases, for the chronic disease permits of long life and practically normal activity, in which forgetfulness cannot be surprising or entirely blameworthy. This program represents a formidable demand upon medical and technical staffs, equipment, and accommodation, but it might be met with multiple teams using routine mass radiography. Anything short of this can hardly represent a useful contribution to preventive medicine, for the infectious person who has not been examined can spread the disease.

Radiographic examination, at three-month intervals, of groups of persons qualifying, say, for the Services, the police, nursing or medical students, will permit us to detect all those with radiographic signs. Some with early infection would be missed, but they would be picked up on the next examination in three months. The necessity for the repeated examinations is due to the fact that we are dealing with a selected group of persons who are in no way prevented from coming into contact with infection at home or during recreation. Unless the infected are detected early, they too could become unsuspected centres of infection, the more dangerous because they had been reported as free from radiographic signs of disease. By such enforced periodic examination tuberculosis in those groups could be kept at a very low figure. It would be possible to lower the figure and perhaps even extend the interval between examinations if we could prevent infection from outside the groups. For regularly repeated radiographic investigation of the entire population—and this would be necessary if possible sources of infection are to be eliminated—the prodigious demand upon staff, equipment, accommodation, and time of all concerned, is beyond all reason when so many aspects of life call for attention. To use group examinations to exclude individuals from certain professions or callings is not without serious injustice to them and loss to the calling; they are still members of the community; they have a right to live and receive what treatment is desirable.

EVALUATION OF RADIOGRAPHIC FINDINGS

But what of those who are found to have radiographic evidence of tuberculosis? Many persons are infected and recover completely without any specific treatment, often without knowledge of the nature of their illness. Some of these will show minimal radiographic lesions, but the discovery of these in a general survey of symptomless persons has not the importance it has in patients who are examined because they have symptoms. As I have previously stated—and the statement has been endorsed by several writers—the patient at the onset of the disease may show clinical signs and symptoms, may even have tubercle bacilli in the sputum, yet the

radiographic appearances may be normal. How seldom are we able to show radiographic evidence of miliary tuberculosis when the physician requests it because of the gravity of the symptoms it has produced? The most significant and earliest indications of tuberculosis I have found not accidentally during examination for something else or in routine chest radiography, but in patients suspected by the physician to have recently contracted the disease. In some cases these indications have appeared in a patient who a month or so before had no signs of them; in some cases they can be seen clinically and radiographically to develop rapidly in spite of every known method of treatment. Such minimal lesions do not represent the "healed" form which we accidentally discover by surveys. The discovery of the latter in a symptomless patient involves the authority in the responsibility of determining their significance. This may mean repeated radiography, periods of observation, and extensive investigations, and in the end, because the patient remains symptomless, perhaps for several years, he eventually receives the instructions which well might have been given in the first instance, *i.e.*, to report to his doctor or clinic if certain signs or symptoms develop; and develop they may at any time, five, ten, or twenty years later. Or they may never develop, but during all this time the life of the patient, his social contacts, his living, his insurances have been seriously interfered with without conferring anything but expense on the community.

Brian C. Thompson, who is apparently unfamiliar with patients showing the early clinical signs and symptoms of pulmonary tuberculosis, since he regards them as "freak cases," which he states "can usually be traced to poor x-ray technique or a clerical error in the bacteriological department," is characteristically an enthusiastic advocate of mass radiography. Yet he states: "While there may be no statistical proof that detection and treatment of a small early lesion ultimately improve the individual prognosis, there is not a scrap of evidence to the contrary," and: "Re-examination of persons initially x-ray negative, from a selected group of those continuing in contact with a sputum-positive associate, is so unprofitable that it can be practically neglected."

The members of the public, through its ministers, who were advised by mass radiography advocates, have been told in the papers, on the wireless, and at multiple demonstrations, *that by early detection and treatment the disease can be cured*. Surely they have a right to statistical proof of this if they are to submit to the examination and help to bear its great cost. Further, if we can neglect those known to be continuing in contact with a sputum-positive associate, why bother about the majority who are not so unfortunate?

The chronic cases of pulmonary tuberculosis may show extensive fibrosis of the lungs, cavity formation, and many other complications, but patients who have had the advantage of early diagnosis and sanatorium treatment may be discharged from the sanatoria with these lesions. As long as we cannot enforce compulsory segregation, the most to be hoped for in these cases, from the aspect of preventive medicine, is that they will not infect others; but, except for the publicity of their illness and, we hope, the education they have profited by, they may become joint agents of infection with the undiagnosed cases.

There are many other criticisms which can be levelled at the principle of mass radiography and the manner in which it is conducted. Many of these have been stated in previous papers (1–3).

CONCLUSIONS

The early signs and symptoms of pulmonary tuberculosis should be well taught to all medical students. They should also be taught that it is essential to include an interpretation of a radiograph of the chest by an expert in the records of the findings obtained at a thorough clinical investigation of all patients with signs and symptoms of pulmonary disease; that when the radiographic appearances in such cases are

normal, a further radiograph should be made at a later date, the interval depending on the clinical findings; that treatment depends upon the clinical aspect of the case and not on the radiographic changes—the latter may appear extensive in a patient who is apparently fit—even sanatorium treatment cannot improve upon this.

Periodic roentgen examination should be made of all those in contact with pulmonary tuberculosis and of all those who are engaged in industries associated with dust and noxious fumes known to cause damage to the lungs. The doctor should be given every facility for obtaining a chest radiograph in any case in which he desires it.

In view of the very great expense in time and money which would be involved in carrying out the above recommendations, mass miniature radiography appears the cheaper solution. Regularly repeated mass radiography of a selected group of the population, *i.e.*, the Services, schools, universities, professions, or trades, may be a means of excluding persons from that group who are likely to infect others, but for the population as a whole this is not a material contribution to preventive medicine and it may impose an injustice on the members of the group who happen to show radiographic signs, though these may be of no clinical significance.

Mass radiography of the population without compulsory segregation of all infected persons would involve so many medical and technical offices and so much time, equipment, and accommodation, without materially contributing to preventive medicine and without assurance of freedom from error, that it is unreasonable.

We have neither the trained staffs, equipment, nor accommodation to treat all the infective patients whom we know or find with ordinary present-day methods.

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Vertebra Plana (Calvé)[1]

Report of a Case

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IN A PAPER read before the British Orthopedic Association at Bologna in 1924, Calvé (1*a*) first described a lesion of the vertebral body which he called "a localized affection of the spine suggesting osteochondritis of the vertebral body with the clinical aspect of Pott's disease." At that time he had but two cases to present, one observed by him and one by Brackett (2) of Boston. Four years later, when he wrote his essay for the Robert Jones Birthday Volume (1*b*), he had collected only seven more cases, none of them his own.

In the United States, Buchman (3*a*) was the first author to aid in crystallizing this new disease entity by reporting two cases in 1927 and differentiating the condition from vertebral epiphysitis, or Scheuermann's disease (3*b*). When Sundt (4), a Norwegian orthopedist, searched the world literature in 1935, he was able to gather 21 recorded cases. Several of these, however, were not Calvé's disease in the opinion of Dale (5*a*), who reported two cases, one in 1937 (5*b*) and one in 1942 (5*a*). Sundt's article contains an extensive bibliography. Mezzari (6), reviewing the literature in 1938, mentioned 27 published cases, but added that, on the basis of a questionnaire suggested by Lindstroem, only 17 were typical examples of the disease as described by Calvé. In the United States, cases have been reported by Kuhlman (7) and Mitchell (8); in South America, by de Albuquerque (9) and Allende (10).

The confusion of nomenclature in the literature increases the difficulty of coming to a correct diagnosis. Many different names have been applied to this condition, the more common being osteochondritis of the vertebral body (Buchman, 3), osteochondritis deformans vertebrae (Voke, 11), infantile pseudospondylitis (Mezzari, 6), and vertebra plana (Calvé, 1). Because of the great degree of flattening of the vertebral body, I prefer the descriptive term, vertebra plana. There is no evidence in support of osteochondritis, as the disease is not characterized by inflammation of bone or cartilage.

Vertebra plana occurs in children between two and fifteen years of age. Most frequently, according to Kuhlman (7), it is observed in those whose ages range from five to ten years. Mezzari (6), however, believed the age of predilection to be between four and seven years. In the case to be presented here the age of the child was three years. The condition is observed with approximately equal frequency in the two sexes. The children most commonly affected are healthy, active, and often moderately overweight; in these children the epiphyses are growing more rapidly than in those who develop more slowly.

ETIOLOGY

The present conception of vertebra plana is that it is due to a primary aseptic necrosis of the body of the vertebra, which in turn is the result of an interference or a blocking of the blood supply. The cause of damage to the blood vessels, circulatory dysfunction subsequent to a disease of the vasomotor fibers or a change in the arterial tonus, is unknown. Vertebra plana follows in the spine a course similar to that of coxa plana in the hip.

The etiology is not definitely known. In a fairly high percentage of cases an acute infectious disease precedes the onset of symptoms. In most of the cases reported there is a history of a relatively slight trauma. Other suggested causes include endocrine disturbance, rickets, and congenital anomaly. Buchman (3*a*) believed there is "an imbalance between the static

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Figs. 1 and 2. Roentgenograms made on Oct. 26, 1933, a few days after the onset of symptoms. The second lumbar vertebra is compressed and has a wedge-shaped appearance. The intervertebral spaces are well preserved. The anteroposterior view shows a collapse of the second lumbar vertebra. There is no evidence of a paravertebral abscess.

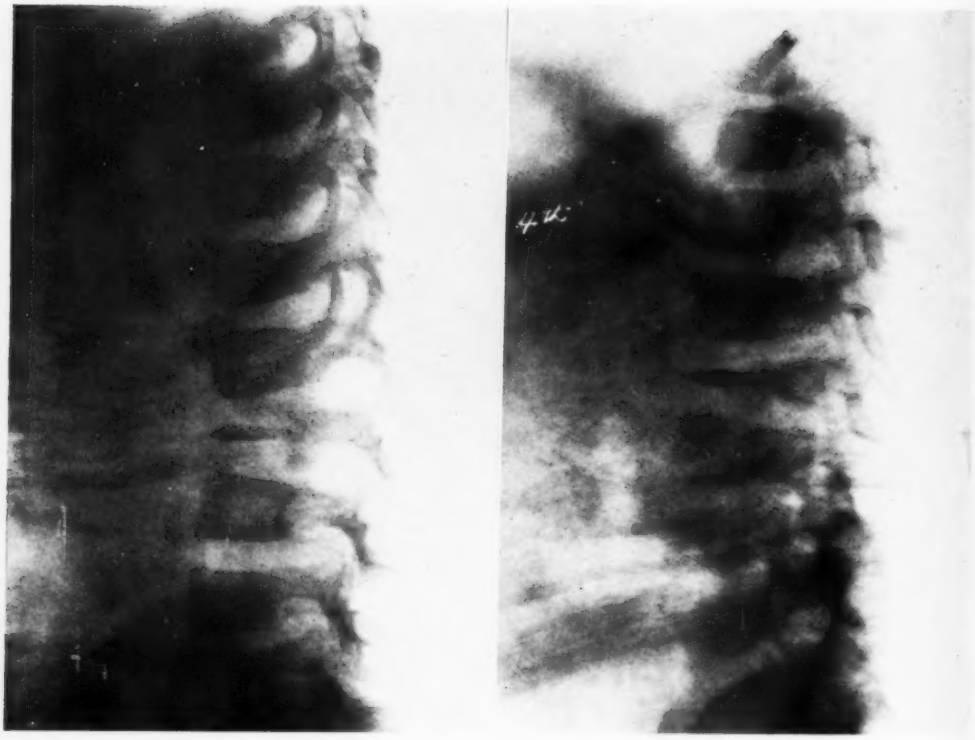
demand and the static capacity." Calvé (1) originally favored infection as the most probable causative agent. Later, he concluded that the disease is a process of aseptic necrosis.

Overton (12) offered the plausible theory that when the demand of the epiphysis for nourishment is greater than the supply, nutrition of the epiphysis is insufficient. As he observed, during the most active period of growth of the epiphysis the vascular system is taxed to its physiologic limit in supplying the needed nutrition; with a demand for increased nutrition, requiring of necessity an increase in the circulatory supply to the epiphysis, imbalance occurs, and because of the inadequate nourishment anemia results in the central subchondral zone, that part of the epiphysis which normally has the least supply of blood.

Harbin and Zollinger (13), after an extensive review of the literature, concluded that localized necroses of bone should be considered a single entity regardless of the part of the skeleton involved. They classified the disease as an osteochondritis of the growth centers.

PATHOLOGY

Pathologically, aseptic necrosis takes place, with secondary fragmentation and collapse of the body of the vertebra, followed by regeneration of the bone. The pathologic process is similar to that described by Hodges, Phemister and Brunschwig (14) in Legg-Calvé-Perthes' disease of the hip and in other necrotizing lesions of bone. The necrotic bone breaks down and is gradually compressed. At first the vertebral body assumes a wedge-shaped deformity. Gradually it is reduced to a thin wafer-like disk, the dead bone being compressed into the remaining cancellous spaces. The intervertebral disks are preserved. The first stage of disintegration



Figs. 3 and 4. Roentgenograms made thirty-four and seventy-seven days after those reproduced in Figs. 1 and 2. On Nov. 30, 1933 (left), the body of the vertebra appears as a thin dense disk. The intervertebral spaces are of normal width. After seventy-seven days (right), the stage of compression and osteolysis is complete, ending the period of degeneration and disintegration, the first of the two distinct phases of the process. Only a wafer-like remnant of the old body remains (Jan. 12, 1934).

and collapse is followed by a protracted reparative period in which regeneration of the bone occurs. According to Phemister (15), repair of aseptic dead bone is accomplished after the revascularization and invasion of necrotic bone by osteogenic tissue, the dead bone being replaced by new bone. The rate and completeness of replacement depend largely on the amount of revascularization and on freedom from weight-bearing. The longer the period of immobilization, the more rapid and complete is the restoration. The pathologic study of Mezzari's classical case showed that the necrosis of the vertebral body was entirely aseptic in character, without any trace of inflammation, with revascularization and partial regeneration of the bone (6).

SYMPTOMS

In his early description of this disease entity, Buchman (3*a*) mentioned that it is characterized by an insidious onset, moderate or slight pain, fatigue, night cries, muscle spasm, tenderness, and knuckle formation or deformity in the form of generalized kyphosis or scoliosis. In proportion to the pathologic change demonstrated in roentgen studies, the symptoms seem to be mild, as they were in the case here reported.

ROENTGEN DIAGNOSIS

Roentgenograms establish the diagnosis. Usually only one vertebra is involved, although it is reported that occasionally more than one may be affected. The two distinct phases of the process are well illus-

trated in the case presented. In the early stages, the period of degeneration and disintegration, there was a wedge-shaped deformity of the involved second lumbar vertebra (Figs. 1 and 2), with a preservation of the intervertebral disks. This was rapidly followed by progressive flattening and compression of the vertebral body until a thin disk of bone of increased density

Fig. 5. Roentgenogram made July 6, 1934, nine months after the onset of symptoms. The body of the vertebra has become elongated, and there has been a slight increase in its height. The second phase, the period of regeneration and reconstruction, has now begun.

remained (Figs. 3 and 4). The adjacent intervertebral disks were of normal width, or slightly wider than normal. The integrity of the intervertebral disks above and below the affected body was characteristically maintained. After the period of degeneration was completed, the phase of regeneration or reconstruction began. Nine months after the onset, the vertebral body had become elongated, with a slight increase in the height (Fig. 5). The intervertebral spaces were wider than normal. The growth of the body was progressive,

Fig. 6. Evidence of the increased height of the vertebral body and of the great regeneration of bone is presented in this roentgenogram, made Dec. 30, 1937, four years and two months after the onset. Note the anteroposterior increase in the length of the vertebral body with concave indentations along the superior and inferior borders, caused by nodular protrusion of the nucleus pulposus, or Schmorl's nodes.

but the period of growth was greatly protracted (Figs. 6 and 7). Eleven years after the onset, the body had attained approximately 100 per cent of its normal size (Figs. 8 and 9). The intervertebral spaces were well preserved.

DIFFERENTIAL DIAGNOSIS

Clinically, vertebra plana is doubtless frequently diagnosed as tuberculosis of the spine. In this latter condition, chiefly a disease of childhood, an irregular destruction of one or more vertebral bodies is followed by their collapse and involvement of the intervertebral disk. Thinning of the intervertebral disks may be the earliest sign of the disease. There is one type of tuberculosis which strongly simulates vertebra plana. Here the flattened body of increased density represents two fused collapsed bodies as revealed by two neural arches attached posteriorly to the flattened mass. Vertebra plana is, therefore, easily distinguished from tuberculosis of the spine

Fig. 7. Roentgenogram of Sept. 30, 1941, showing further growth of the vertebral body. It has now attained 75 per cent of its normal size. The reparative stage has been greatly protracted.

by the appearance of a flat body of increased density, the absence of loss of the intervertebral space, the regeneration of the body, and the fact that almost without exception only one body is involved. The destructive changes in tuberculosis of the spine are frequently accompanied by a fusiform shadow about the diseased area due to a paravertebral abscess.

Vertebra plana is a distinct entity to be distinguished from the so-called vertebral epiphysitis or Scheuermann's kyphosis dorsalis juvenilis. This is usually a disease of early adolescence. There is, as a rule, a well defined dorsal kyphosis with involvement of several thoracic vertebrae, in most instances limited to the lower half of the thoracic spine. The most constant change is irregularity of the upper and lower surfaces of the vertebrae, particularly at their anterior margins. This is usually accompanied by an irregularity in epiphyseal calcification. The epiphysis appears to be fragmented. With these changes there is a slowly progressive wedging of the involved vertebral bodies.

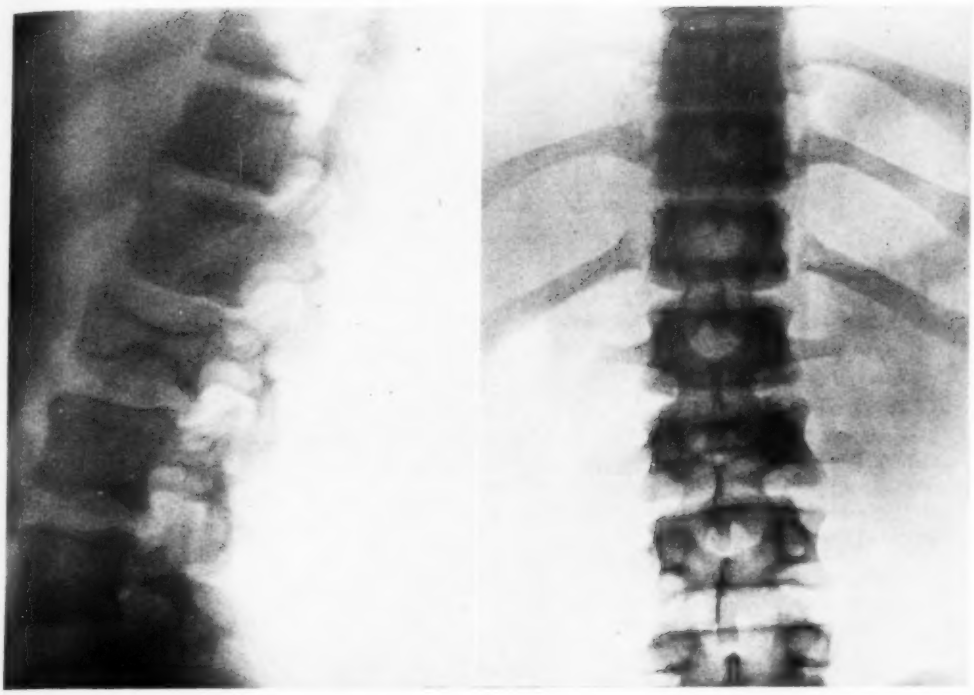
In hyperfunction of the parathyroid glands in which there is a disturbance of calcium metabolism, there is a general decalcification involving the entire skeleton. One or more thoracic vertebrae may have a uniform shortening without involvement of the intervertebral disks.

Osteoporosis and metabolic disturbances are also to be considered. In the rare forms of hunger, traumatic, and metabolic decalcification, there may occur a flattening of the vertebrae with much swelling of the nucleus pulposus, producing a concave deformity on the superior and inferior borders of the weakened decalcified vertebral bodies.

Malignant tumors of the spine are likewise to be differentiated. Such lesions are rare in childhood. Sarcoma, Ewing's tumor, and hypernephroma all produce destruction of vertebrae without distinguishing characteristics. A giant-cell tumor, myeloma, or hemangioma may show typical changes. Collapse of vertebral bodies with preservation of the intervertebral space and articular cortex is also indicative of a metastatic malignant neoplasm.

TREATMENT AND PROGNOSIS

Recumbency and immobilization of the spine by means of a plaster-of-paris jacket have given satisfactory results in the treated cases. Adequate treatment by prolonged immobilization shortens the reconstructive phase, while activity and inadequate immobilization prolong it. A favorable prognosis is warranted as to the ultimate outcome. The remaining deformity does not interfere with activity. In the case presented, complete regeneration was demonstrable after eleven years; a shorter time might have been required had the period of immobilization been sufficiently prolonged.



Figs. 8 and 9. Roentgenograms made Oct. 19, 1944, eleven years after the onset of the disease. The complete regeneration of the vertebral body is well demonstrated in the lateral view. The height of the vertebra is the same as that of normal lumbar vertebrae. The concave indentations along the superior and inferior borders are still evident. The anteroposterior view shows the complete regeneration of the body of the vertebra with no evidence of a paravertebral abscess. The intervertebral spaces are well preserved.

REPORT OF CASE

A white boy, aged 3, was admitted to Columbus Hospital, New York, on Oct. 25, 1933. His mother related that some days previously he had fallen from a trunk about 2 feet in height, but had not complained, although he had fallen on the spine. A few days later she had noticed that, when he wanted to pick up something from the floor, he would bend the knees and keep the back straight, without, however, complaining of pain. One week later he complained of pain in the region of the umbilicus. At the time of admission he walked in a position of lordosis, with the abdomen protruding and the shoulders thrown back.

The child was well developed, well nourished, and healthy. There was slight tenderness on pressure over the lumbar spine. Neurologic examination, made by Dr. David Impastato, gave no evidence of sensory changes in the gluteal region or lower limbs, nor was there any change in the reflexes of the lower limbs. There were no pathologic reflexes and no atrophy nor fibrillation of the gluteal muscles.

The temperature was normal. The hemoglobin estimation was 75 per cent; the red blood cell count was 4,250,000; the white blood cell count was 7,400, and the differential count showed mature neutrophils 60 per cent and lymphocytes 30 per cent. Reaction to the Wassermann, Kahn, and tuberculin tests was negative. The blood calcium content was 8 mg. per 100 c. c., and the sedimentation time was one hour and twenty minutes.

Roentgen examination was made on Oct. 26. Roentgenograms of the lumbar spine showed that the second lumbar vertebra was compressed and wedge-shaped in appearance (Fig. 1). The intervertebral spaces were, however, well preserved. An anteroposterior view showed a collapse of this vertebra (Fig. 2). There was no evidence of a paravertebral abscess. Roentgenograms of the skull, thoracic spine, thorax, pelvis, and extremities demonstrated no pathologic change in bones or joints.

On Oct. 27, a plaster-of-paris jacket extending from the shoulders to the hips was applied. Roentgenograms made on Nov. 30 showed that the body of the vertebra had become a thin dense disk (Fig. 3). The intervertebral spaces were of normal width. On December 23, against the advice of the attending physician, the parents took the patient home and soon removed the cast, but they permitted the child to be kept under observation. No doubt the re-

generative process would have progressed more rapidly had the period of immobilization been prolonged.

On Jan. 12, 1934, seventy-seven days after the initial roentgen examination, the stage of compression and osteolysis was complete. There remained only a wafer-like remnant of the old vertebral body (Fig. 4). After nine months had elapsed, the body of the vertebra was elongated and slightly increased in height; also, widening of the intervertebral spaces was apparent. The period of reconstruction was now under way, as shown by a roentgenogram made on July 6 (Fig. 5). On Dec. 30, 1937, four years and two months after the onset, roentgen examination gave evidence of greatly increased height of the vertebral body and of much regeneration of bone (Fig. 6). Roentgenograms made on Sept. 30, 1941, seven years and eleven months after the onset, demonstrated further growth of the body, which had now regained three-fourths of its normal size (Fig. 7). The regenerative phase is now complete, after eleven years, with full restoration of the height of the body (Fig. 8). The anteroposterior view shows the normal appearance with no evidence of a paravertebral abscess (Fig. 9).

At the present time, the patient, now in his fifteenth year, is overdeveloped and in excellent health. He leads a particularly active life. In spite of the slight deformity of the reconstructed second lumbar vertebra, he complains of no discomfort, and recent physical examination revealed no limitation of motion.

SUMMARY

Calvé's vertebra plana is almost without exception an affection of a single vertebra. It runs a cyclical course. The first or destructive phase of the cycle is relatively rapid, extending through a period of about two months. The second or regenerative phase is greatly protracted and may extend through a period of eight years or more.

The disease occurs in early childhood. The etiology is unknown. Pathologically, the process is one of aseptic necrosis of the vertebral body.

The characteristic roentgen findings are as follows:

(1) A wedge-shaped deformity of the vertebral body is observed in the early phase and is followed by a complete collapse or flattening of this body.

(2) The intervertebral spaces are not affected, or they may be slightly wider than normal.

(3) Regeneration of the vertebral body takes place without proliferation of bone.

(4) Only one vertebral body is usually involved.

A case is reported in which the patient has been under observation for eleven years. With completion of the degenerative phase of the disease in a few months, the regenerative process has since continued to be slowly progressive over this long period of time, and complete regeneration has only recently been demonstrated.

In view of the small number of cases reported, it is probable that the condition is mistaken for tuberculosis of the spine or the so-called vertebral epiphysitis, an error suggesting that made regarding coxa plana before Legg, Calvé, and Perthes (5, 8, 12) differentiated it from tuberculosis of the hip.

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Metallic Foreign Bodies in the Gallbladder: Case Report[1]

MARK S. DONOVAN, M.D.

Denver, Colo.

THE RARITY with which inanimate foreign bodies spontaneously find their way into the gallbladder makes the following case seem worthy of recording. In this instance two metal needles or pins were found in the gallbladder of a patient who had no previous accident or operation to account for their presence.

Mrs. L. B., a 52-year-old white housewife, was admitted to Mercy Hospital (Toledo, Ohio), complaining of occasional attacks of sharp pains in the *left* upper abdominal quadrant, lasting a few hours and unrelated to meals or to exertion. She had never been jaundiced, had noticed no clay-colored stools, and even on close questioning gave no history of pain in the right side of the abdomen, back, or shoulder. Her past history was non-contributory. She had never had an abdominal operation.

Physical examination revealed nothing of note. There was no tenderness in the abdomen, and no enlarged organs or masses were palpable. There was no abdominal scar. Routine laboratory studies of the blood and urine gave normal findings.

Oral cholecystography, with Priodax, revealed a faint gallbladder shadow in normal position in the abdomen, and films taken in all projections showed two metallic foreign bodies within the gallbladder shadow, each having a faintly positive calculus near one end. They were freely movable, lying first parallel and later across each other (Fig. 1).

On the next two days, roentgen examinations of the colon and upper gastro-intestinal tract were done, the only noteworthy finding being a smooth shallow defect on the upper border of the duodenal bulb, as from external pressure. This was interpreted as suggesting adhesions between the bulb and the gallbladder, since in all projections the metal needles lay very close to the bulb and could not be separated from it by pressure.

The patient could not recall having swallowed any needles or pins but stated that for many years she had made her own clothing, so we may assume she had ample opportunity to swallow such objects.

Cholecystectomy was done a few days thereafter. The gallbladder, which was tightly adherent to the first portion of the duodenum, was removed intact with the cystic duct. On opening the gallbladder in the laboratory, a short piece of one needle was broken off and it was immediately apparent that both needles were much corroded. Each was 2.5 cm. in length and each had a very soft, friable stone around it, about 1 cm. in diameter. Unfortunately the specimens were exposed to the air for nearly a day before they were photographed, at which time the calculi had spontaneously disintegrated, probably consisting largely of cholesterol (Fig. 2).

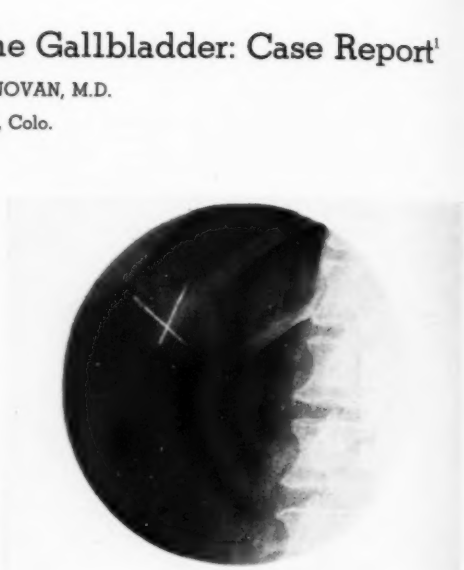

Fig. 1. Cholecystogram, oral method, showing two metallic foreign bodies within the faint gallbladder shadow. The outline of one cholesterol calculus is fairly distinct. The other calculus, which was found at operation, cannot be distinguished.

The postoperative course was uneventful and the patient was discharged after two weeks. When seen several months later, she looked well and stated that she was free of all symptoms.

Most of the foreign bodies previously reported as being found in the biliary system are objects—such as bits of gauze—accidentally left after surgical operations. A complete search of the *Quarterly Cumulative Index* reveals very few reports of the spontaneous migration of inanimate foreign bodies into the gallbladder. Wallin (4) found a watermelon seed in the gallbladder of a cadaver during anatomical dissection. This had apparently migrated up the common bile duct from the duodenum. Only one instance similar to the case under discussion was discovered. This was reported in 1909 by Eastman (1). His patient, a woman, had had "left-sided pains (sug-

[1] From Mercy Hospital, Toledo, Ohio. Accepted for publication in December 1944.

gestive of adhesions between the pylorus and the gallbladder)" and attacks of gallstone colic. At operation the gallbladder was found to be adherent to the pylorus and to contain numerous stones, together with an ordinary short sewing needle encrusted with bile salts. Eastman surmised that the patient had swallowed the needle while sewing, although she did not remember doing so, and that it passed directly from the pylorus to the gallbladder. The curious occurrence of left-sided abdominal pain is noteworthy here, as this was also the chief complaint in the case described above.

Another case of this type, apparently unrecorded, is mentioned by Trousseau (3) who states merely that a M. Nauche had found a pin as the nucleus of a gallstone.

Toland (2) reviews the literature on foreign bodies in the biliary tract in reporting his own case, in which a piece of gauze had been left in the common bile duct after operation. He says: "It is logical to assume needles and other sharp objects that have been swallowed and reached the pylorus might migrate by direct contiguity into the gallbladder. The curious circumstances that lead to such migration are difficult to visualize."

The only logical explanation in the case recorded above for the presence of the needles in the gallbladder seems to be that they passed directly into it from the first portion of the duodenum. This has previously been shown to have happened with one needle (1) but the occurrence of two such objects in the gallbladder seems doubly curious.

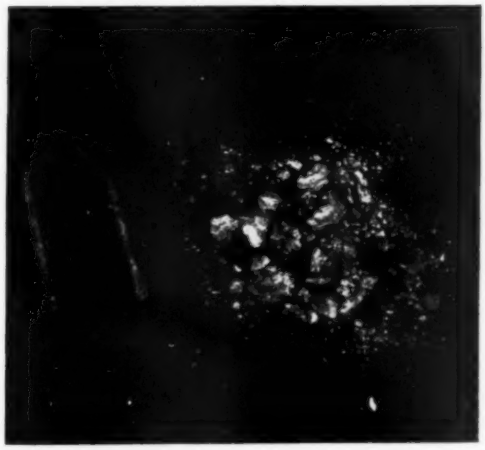

Fig. 2. Photograph of metal "needles," taken after the very friable calculi which had surrounded one end of each foreign body had spontaneously disintegrated.

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EDITORIAL

Congenital Atresia of the Esophagus

Medical history is replete with epics telling of diseases which have been conquered by new advances in medicine and surgery. These chronicles of patient and persevering study by enthusiastic scientists who have refused to admit the possibility of failure stand as milestones in medical progress. The recent successes reported in the treatment of congenital atresia of the esophagus with tracheoesophageal fistula are representative of such achievements, indicating that a considerable number of cures can be obtained if a prompt diagnosis is followed by appropriate surgery.

The successful management of esophageal atresia depends upon the clinical recognition of its possibility, its roentgenologic proof, and its surgical treatment. It is essential that each of these steps be taken promptly if an ultimately good prognosis is to be assured.

The clinician should suspect the existence of a congenital obstruction of the esophagus when a newborn infant has an excess of mucus in its mouth, with attacks of choking and perhaps cyanosis when feeding is attempted. All the feedings are vomited, and death from inanition may threaten. Actual obstruction may be demonstrated by the introduction of a catheter, which fails to pass down the esophagus into the stomach, or by roentgen study.

Roentgen examination with the aid of a small quantity of iodized oil administered under fluoroscopic control will show a blind upper esophageal pouch, usually terminating at about the level of the second or third dorsal vertebra. The use of barium as a contrast medium is contraindicated because of the possibility of its aspiration and the consequent danger of a fatal bronchopneumonia. Even with lipiodol, care must be taken to avoid spilling over into the trachea and aspiration. To obviate any possibility of opaque material reaching the lung, Fuhrman, Dragutsky, Rook, and Grossman (1, 2) advocate a procedure which they designate aeroesophography, in which the upper esophageal pouch is outlined by air injected through a soft rubber catheter introduced through the naris and passed downward toward the stomach under fluoroscopic guidance. Such a procedure should decrease the hazards of examination to a considerable extent and lessen the usually high mortality from bronchopneumonia.

In 1929 Vogt (7) classified cases of congenital esophageal atresia under three main headings. In Type 1 there is complete absence of the esophagus (very rare). In Type 2 both segments end in a blind pouch (rare). In Type 3 there is a fistulous connection with the trachea. This third type is further subdivided into Type 3 A, in which the communication is between the upper segment and the trachea; Type 3 B, in which the fistula is between the lower segment and the trachea; Type 3 C, in which both segments communicate with the trachea. Over 90 per cent of the reported cases are of Type 3 B. Demonstration of air in the stomach and intestines in the presence of complete obstruction of the upper esophagus indicates the presence of a communication between the lower esophagus and the trachea or a bronchus. This is an important observation from the point of view of surgical treatment.

Two types of operative procedure have been employed in an attempt to correct congenital atresia of the esophagus. The

earlier operation was done in multiple stages, designed (1) to feed the patient by means of a gastrostomy, (2) to close the fistula between the lower segment and the trachea, and (3) to drain the upper segment by exteriorization. Later an extrathoracic skin tube must be constructed if the procedure is to be termed successful. The second or direct method contemplates the restoration of the continuity of the esophagus by direct anastomosis. This operation is carried out in one stage. After extrapleural exposure, the fistula is ligated and the two segments are anastomosed. If this is successfully accomplished, the normal swallowing act is restored. This seems definitely to be the operation of choice.

The first case successfully treated by the indirect method was recorded by Leven (6) in 1941, although at the time of the report the extrathoracic tube to replace the intrathoracic esophagus had not been completed. Up to the present time 34 cases treated by the indirect method have been published. Fifteen of the patients were reported as living, but in only two had the artificial esophagus been completed.

In 1943 Haight and Towsley (3) reported the first successful direct anastomosis of the two esophageal segments, their patient at that time having reached the age of one year. Their success was preceded by numerous reports of failure on the part of several surgeons. It has been followed by both successes and failures. The cause of failure may be anatomical, since the segments are sometimes so widely separated that they cannot be brought together for anastomosis. Probably the greatest hazard is the supervention of bronchopneumonia from aspiration of food.

In a subsequent report by Haight (4) a total of 16 attempts at direct anastomosis are described, with 6 or 37.5 per cent of the patients alive, with a patent esophagus. Lam (5) in a paper shortly to be published presents 2 cases in which direct anastomosis was done, and both patients are living and well. Of 2 other patients more recently treated by Lam, one is living and able to take food naturally.

This then is the story of a condition that has been considered by most clinicians as incompatible with life and as incurable. The successes reported are the result of a perfected surgical technic and represent another advance in the brilliant history of surgery. In this achievement the clinician and roentgenologist may cla'm a share, as the early recognition and demonstration of the lesion are essential to surgical success.

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BRONZE STAR AWARDED TO LIEUTENANT COLONEL LEDOUX

Lt. Col. Alfred Campbell Ledoux, of Evanston, Ill., a member of the Radiological Society of North America, has been awarded the Bronze Star Medal for meritorious service as Chief of X-Ray and Radiotherapy Services, 108th General Hospital, European Theatre of Operations, from Sept. 1, 1944, to May 8, 1945. The citation reads: "Lieutenant Colonel Ledoux was chiefly instrumental in the discovery, reconstitution and speedy adaptation of captured x-ray and radiotherapy equipment. This accomplishment was the direct result of his initiative, specialized technical knowledge, linguistic aptitude, and high professional attainments. The immediate availability of such splendid equipment at a time when transportation of our own material was extremely difficult and uncertain, due to the exigencies of the military situation, materially assisted in the diagnostic care and treatment of many thousands of casualties and made the contribution of Lieutenant Colonel Ledoux of immeasurable value."

CANCER TEACHING DAYS

Four Cancer Teaching Days will be observed in New York in October, under joint state and county auspices. The first will be held in Oneonta, Otsego County, on Oct. 3, at the Homer Folks Tuberculosis Hospital. Preceding the formal sessions there will be a Clinical Demonstration and Discussion of Patients by Dr. Wm. A. Milner of Albany Medical College and Drs. Fred W. Stewart, Norman Treves, and Gray H. Twombly, all of Memorial Hospital, New York City. At the afternoon session, at 4 o'clock, Dr. Twombly will speak on "Ovarian Carcinoma" and Dr. Treves on "Cancer of the Breast." In the evening the speakers will be Dr. Milner, on "Carcinoma of the Bladder," and Dr. Stewart on "Biopsy in Tumors."

On Oct. 9, a single session will be held in Rochester at the Academy of Medicine, at 8 P.M. The speakers will be Dr. John H. Garlock, of Mt. Sinai Hospital, New York City, on "Carcinoma of the Colon," and Dr. John J. Morton, Jr., of the University of Rochester School of Medicine and Dentistry, on "Progress in Cancer Research."

On Oct. 17, meetings will be held in Kingston, Ulster County, in the Governor Clinton Hotel, at 3:30 and 7:30. In the afternoon, Dr. Earle D. Osborne, of the University of Buffalo School of Medicine, will discuss "Cancer of the Skin and Allied Tumors," and Dr. Frederick S. Wetherell, of Syracuse University College of Medicine, "The Role of the Practising Physician in the Care of Cancer." The evening speakers will be Dr. Chas. B. Huggins, of the University of Illinois, on "Cancer of the Prostate" and Dr. Fred Stewart on "Biopsy in Tumors."

At Albany, the sessions will be held in the Albany College of Pharmacy, on Oct. 18. At the 3:30 meeting Dr. Hayes Martin of Memorial Hospital, New York City, and Dr. Chas. B. Huggins will be the speakers, their subjects being, respectively, "Cancer of the Head and Neck" and "Cancer of the Prostate." In the evening Dr. George T. Pack, of Memorial Hospital, will speak on "Cancer of the Stomach" and Dr. Clyde L. Randall, of the University of Buffalo School of Medicine, on "Hormone Therapy and the Prevention of Gynecologic Malignancies."

Dinner reservations for the Oneonta, Kingston, and Albany meetings should be sent in advance to Ralph Horton, M.D., Homer Folks Tuberculosis Hospital, Oneonta; Frederick H. Voss, M.D., 69 Spring St., Kingston; Arthur F. Holding, M.D., 142 Washington Ave., Albany 6.

In Memoriam

ISAAC LEVIN, M.D.

1866–1945

Dr. Isaac Levin, well known as a radiologist and for his interest in cancer research, died at the age of 78 on June 19. Dr. Levin was born in Russia, in 1866. He received his medical education there and served as attending surgeon in the Army Hospital in St. Petersburg before emigrating to America. He was an associate in pathology at Columbia University, New York, from 1909 to 1912 and associate in cancer research in that university from 1912 to 1915. He was clinical professor of cancer research in the University and Bellevue Hospital Medical College for many years and was at one time chief of the cancer division of Montefiore Hospital. From 1923 to 1930 he was director of the New York City Cancer Institute. He was consultant radiologist at Lebanon Hospital.

Dr. Levin was a diplomate of the American Board of Radiology and held membership in many scientific societies, including the Radiological Society of North America, American College of Radiology, Society for Experimental Biology and Medicine, the American Association of Pathologists and Bacteriologists, Harvey Society, American Physiological Society, American Genetic Association, American Association for Cancer Research, and American Radium Society.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be pub-

lished in the interest of our readers and as space permits.

PUBLICACIONES DEL CENTRO DE INVESTIGACIONES TISIOLOGICAS. Director: Prof. Roque A. Izzo. Volume VIII. Pabellon "Las Provincias," Hospital Tornú, Buenos Aires, 1944.

Book Reviews

SHOULDER LESIONS. By H. F. MOSELEY, M.A., D.M., M.Ch., Assistant Surgeon, Royal Victoria Hospital, Montreal. A volume of 181 pages, with 71 illustrations. Published by Charles C Thomas, Springfield, Ill., 1945.

So much progress has taken place since the monumental work of Codman on the shoulder that this short and concise monograph should be welcome, as it presents an excellent discussion of our present knowledge of the subject. The author discusses the use of local infiltration of procain as a therapeutic and diagnostic aid, emphasizing its great value. He is of the opinion that novocaine injection can restore full movement and power in an injured or painful shoulder in spite of the presence of a complete rupture of the supraspinatus tendon. The return of full function after injection is considered to be accompanied by an excellent prognosis. This belief that full movement can occur in the presence of a torn musculo-tendinous cuff is somewhat in disagreement with the writings of many authorities.

Bicipital syndromes are described as tendinitis and tenosynovitis, partial and complete rupture of the tendon and recurrent subluxations of the tendon. The importance of these lesions and their role in the early stages of a frozen shoulder are well described.

There are interesting chapters on the neurological aspects of shoulder pain by McNaughton, and one on roentgen diagnosis and treatment by Bouchard and Peirce. Other chapters deal with examination and kinesiology of the shoulder, rupture of the rotator cuff, subluxation and dislocation, periarthritis, and operative approaches and procedures.

The writer summarizes the pathology of dislocation as follows: In simple dislocation the morbid anatomy is a tear of the capsule and subscapularis tendon from the neck of the humerus, which eventually heals. In true recurrent dislocating shoulder the initial dislocation results in a tearing of the capsule in the antero-inferior area of the glenoid rim or humeral neck. This fails to heal back completely, due to a second injury a short period later, followed by repeated stretching and failure of fibrocartilage to heal. With these changes is associated a weakening of the muscles around the shoulder due to disuse. This disuse is due to the tendency to treat dislocated shoulders after reduction in a sling for varying periods, from two to four weeks, without any attempt at re-education of those muscles in movements or power. Thus, the main strength of the shoulder joint is lost, with a tendency to dislocate with less force than was previously required. By a correlation of the pathology, mechanism, and treatment, the writer draws the conclusion that the Bankart procedure or plastic repair of the anterior capsule in cases of torn subscapularis tendon should replace all others in the therapy of recurrent dislocations of the shoulder.

Of considerable value is the strong emphasis which is placed upon the role of weak and atrophic muscles in the clinical picture which follows shoulder injuries. There is a careful description of the technics of re-education and the active use of voluntary movements, which should lead to the creation of a powerful musculature and therefore to shoulder stability.

RADIOLOGICAL SOCIETIES OF NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

UNITED STATES

Radiological Society of North America.—Secretary, D. S. Childs, M.D., 607 Medical Arts Bldg., Syracuse 2, N.Y.

American Roentgen Ray Society.—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

American College of Radiology.—Secretary, Mac F. Cahal, 20 N. Wacker Dr., Chicago 6, Ill.

Section on Radiology, American Medical Association.—Secretary, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

ARKANSAS

Arkansas Radiological Society.—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

CALIFORNIA

California Medical Association, Section on Radiology.—Secretary, Gordon King, M.D., Children's Hospital, San Francisco.

Los Angeles County Medical Association, Radiological Section.—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Acting Secretary, Frederick H. Rodenbaugh, M.D., 490 Post St., San Francisco. Meets annually with California Medical Association.

San Diego Roentgen Society.—Secretary, Henry L. Jaffe, M.D., U. S. Naval Hospital, San Diego, Calif. Meets first Wednesday of each month.

San Francisco Radiological Society.—Secretary, Carlton L. Ould, University Hospital, Medical Center, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year in Lane Hall, Stanford University Hospital, and second six months in Toland Hall, University of California Hospital.

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Denver Radiological Club.—Secretary, A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month, Denver Athletic Club.

CONNECTICUT

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Chicago Roentgen Society.—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Secretary, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

INDIANA

The Indiana Roentgen Society.—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

IOWA

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KENTUCKY

Kentucky Radiological Society.—Secretary-Treasurer, Sydney E. Johnson, 101 W. Chestnut St., Louisville.

LOUISIANA

Louisiana Radiological Society.—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

Shreveport Radiological Club.—Secretary, Oscar O. Jones, M.D., 2622 Greenwood Road. Meets monthly September to May, third Wednesday, 7:30 P.M.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Secretary, Charles N. Davidson, M.D., 101 West Read St., Baltimore 1.

MICHIGAN

Detroit X-ray and Radium Society.—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, at Wayne County Medical Society club rooms.

Michigan Association of Roentgenologists.—Secretary, Bruce MacDuff, M.D., 201 Sherman Bldg., Flint 3.

MINNESOTA

Minnesota Radiological Society.—Secretary, A. T. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

MISSOURI

Radiological Society of Greater Kansas City.—Secretary, John W. Walker, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Friday of each month.

St. Louis Society of Radiologists.—Secretary, Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday of each month except June, July, August, and September.

NEBRASKA

Nebraska Radiological Society.—Secretary-Treasurer, Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

NEW ENGLAND

New England Roentgen Ray Society.—Secretary-Treasurer, George Levene, M.D., Massachusetts Memorial Hos-

pitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW HAMPSHIRE

New Hampshire Roentgen Society.—Secretary-Treasurer, Richard C. Batt, M.D., St. Louis Hospital, Berlin.

NEW JERSEY

Radiological Society of New Jersey.—Secretary, H. R. Brindle, M.D., 501 Grand Ave., Asbury Park. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called.

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Associated Radiologists of New York, Inc.—Secretary, William J. Francis, M.D., East Rockaway, L. I.

Brooklyn Roentgen Ray Society.—Secretary-Treasurer, Leo A. Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

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Central New York Roentgen Society.—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings in January, May, and October.

Long Island Radiological Society.—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—Secretary, Wm. Snow, M.D., 941 Park Ave., New York 28.

Rochester Roentgen-Ray Society.—Secretary, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7. Meets at Strong Memorial Hospital, third Monday, September through May.

NORTH CAROLINA

Radiological Society of North Carolina.—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meets in May, and October.

NORTH DAKOTA

North Dakota Radiological Society.—Secretary, Charles Heilman, M.D., 1338 Second St., N., Fargo.

OHIO

Ohio Radiological Society.—Secretary, Henry Snow, M.D., 1061 Reibold Bldg., Dayton 2. Next meeting at annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*Secretary-Treasurer,* Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

Philadelphia Roentgen Ray Society.—Secretary, Calvin L. Stewart, M.D., Jefferson Hospital, Philadelphia 7. Meets first Thursday of each month at 8:00 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St.

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Rocky Mountain Radiological Society (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—*Secretary,* A. M. Popma, M.D., 220 North First St., Boise, Idaho.

SOUTH CAROLINA

South Carolina X-ray Society.—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Dallas-Fort Worth Roentgen Study Club.—Secretary, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth, Texas. Meetings on third Monday of each month, in Dallas in the odd months and in Fort Worth in the even months.

Texas Radiological Society.—Secretary-Treasurer, Asa E. Seeds, M.D., Baylor Hospital, Dallas.

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Virginia Radiological Society.—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

WASHINGTON

Washington State Radiological Society.—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

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ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

HADLEY, LEE A. Platybasia and Occipital Vertebra Causing Foramen Magnum Encroachment and Resulting Neurologic Symptoms.. 302

RAAF, JOHN. Eosinophilic Granuloma of the Skull.... 302

COSTEN, JAMES B. Diagnosis of Mandibular Joint Neuralgia and Its Place in General Head Pain.... 302

FOSTER, JOHN H. Fibrosarcoma of the Larynx.. 303

The Chest

HARDT, HARRY G., JR. Wounds of the Chest in Pacific Jungle Warfare: Review of Thirty-Two Cases.... 303

MORSE, DAN G. The Chest X-Ray.... 303

REST, ARTHUR. Role of the Roentgenogram in Tuberculosis Finding.... 304

JOHNSON, JESSE B., AND WALLACE, W. S. Tuberculosis Among Medical School Personnel at the University of Texas from 1941 to 1944.. 304

DUNCAN, J. T., AND MCKINLEY, C. SCOTT. Tuberculosis in West Virginia Industries.... 304

ROMENDICK, SAMUEL S., FRIEDMAN, BERNARD, AND SCHWARTZ, HERBERT F. Lower Lung Field Tuberculosis.... 305

LOESCH, JOHN. Closure of Tuberculous Cavities. 305

KASSOWITZ, KARL E. Healed Asymptomatic Miliary Tuberculosis.... 305

PERRY, C. BRUCE. Aetiology of Erythema Nodosum.... 305

JORESS, MARK H., AND ROBINS, SAMUEL A. Diagnosis of Bronchiectasis: Clinical and Roentgenological Observations.... 306

GOLDMAN, ALFRED, AND ROTH, HAROLD. Spontaneous Pneumothorax: Report of Three Unusual Cases.... 306

DAVIDSON, LOUIS R. Hydatid Cysts of the Lung. 306

LOWMAN, ROBERT M., AND CULOTTA, CHARLES S. Pneumomediastinum in the Newborn.... 307

MILLER, HENRY. Spontaneous Mediastinal Emphysema.... 307

LADD, WM. E., AND SCOTT, H. WM., JR. Esophageal Duplications or Mediastinal Cysts of Enteric Origin.... 308

STRAUS, BERNARD. Chronic Constrictive Pericarditis Due to a Foreign Body (Needle) in the Pericardium.... 308

ZIZMOR, J., AND SZUCS, M. M. Echinococcus Cyst of the Heart: Report of a Case.... 309

The Digestive System

KIEFER, EVERETT D. Diagnosis of Disorders of the Small and Large Intestine.... 309

BROWN, J. SCOTT, AND TROWELL, H. C. Deficiency Bowel Pattern in Polish Refugees, African and Indian Adults and Children (Kwashiorkor).... 309

SILVERMAN, DANIEL N., AND LESLIE, ALAN. Simulation of Chronic Bacterial Dysentery by Paratyphoid B Infection.... 310

WATSON, C. J., RIGLER, L. G., WANGENSTEEN, O. H., AND MCCARTNEY, J. S. Isolated Sarcoidosis of the Small Intestine Simulating Non-Specific Ileo-Jejunitis.... 310

SHALLOW, THOMAS A., EGER, SHERMAN A., AND CARTY, JAMES B. Primary Carcinoma of the Third Portion of the Duodenum.... 310

TILTON, BENJAMIN T. Carcinoma and Lymphosarcoma of the Colon. A Case of Lymphosarcoma of the Descending Colon.... 311

SOSMAN, M. C. Radiologic Aspect of Gall-Bladder Disease.... 311

SAGE, HAROLD H. Multiple Diffuse Pancreatic Lithiasis. Roentgen Anatomy of the Pancreas: Case Report.... 312

The Skeletal System

WAGONER, GEORGE W., HUNT, ANDREW D., JR., and PENDERGRASS, EUGENE P. Study of the Relative Importance of the Cortex and Spongiosa in the Production of the Roentgenogram of the Normal Vertebral Body... 312

MARSHAK, ALFRED, AND BYRON, R. L., JR. A Method for Studying Healing of Bone.... 312

LEONARD, DONALD W. Early Recognition of Endocrine Disorders in Childhood by Roentgenograms of the Wrist to Determine the "Ossification Index."... 312

JAMES, THEODORE. Fracture Dislocation of the Ankle Occurring in Flying Accidents.... 313

BONNIN, J. GRANT. Sacral Fractures and Injuries to the Cauda Equina.... 313

SARPYENER, MÜNIR A. Congenital Stricture of the Spinal Canal.... 313

MORTON, H. S., AND CRYSLER, W. E. Osteochondritis Dissecans of the Supratrochlear Septum.... 313

RUBINSTEIN, MICHAEL A. Multiple Myeloma in a Fifteen-Year-Old Boy.... 313

Gynecology and Obstetrics

KING, E. L. Role of Roentgen Pelvimetry in the Management of Pelvic Contraction.... 313

CAMPBELL, RALPH E. The Outlet Contraction with Especial Emphasis on the Typical Funnel Pelvis.... 314

The Genito-Urinary Tract

LOWRY, EARL C., HAYWARD, JOSEPH C., AND BEARD, DONALD E. Diagnosis of Hydronephrosis Caused by Accessory Renal Vessels. 314

GREENE, LAURENCE F. The Renal and Ureteral Changes Induced by Dilating the Ureter. An Experimental Study..... 314

HERMAN, LEON, AND GREENE, LLOYD B. Diverticulum of the Female Urethra..... 314

The Blood Vessels

LEARMONTH, J. R. Arteriography of Peripheral Vessels. Technical Details..... 315

Foreign Bodies

BRAILSFORD, JAMES F. Localisation of Foreign Bodies..... 315

MCGUIRE, WILLIAM P., AND RAFFETTO, EDWARD C. Construction of a Contact Lens for Localization of Intraocular Foreign Bodies.. 316

Technic

MINEAR, W. L. Rapid Roentgenography in the Operating Room..... 316

BIBLER, LESTER D., AND WHITE, DOUGLAS W. X-Ray Technic for Diagnostic Films with the Weber Dental Machine Model-5..... 316

RADIOTHERAPY

FRIEDMAN, MILTON. Supervoltage (One Million Volt) Roentgen Therapy at Walter Reed General Hospital..... 316

ARBUCKLE, M. F., STUTSMAN, A. C., AND MOORE, SHERWOOD. Treatment of Inoperable Cancer of the Throat (Follow-Up of Previous Report)..... 316

WALD, SAMUEL S. Chemotherapy and X-Ray Radiation in Treatment of Cellulitis of the Head and Neck..... 317

ANDREWS, GEORGE C., BRAESTRUP, CARL B., AND HEISEL, ELDRED B. Exit Dose in Dermatologic Roentgen Therapy..... 317

HOWES, WILLIAM E. Tissue Dose Estimation in Combined Roentgen and Radium Therapy for Carcinoma of the Uterine Cervix..... 318

Radiation Effects

GRATZEK, F. R., HOLMSTROM, E. G., AND RIGLER, LEO G. Post-Irradiation Bone Changes.... 318

DEAN, ARCHIE L., AND ABELS, JULES C. Study by the Newer Renal Function Tests of an Unusual Case of Hypertension Following Irradiation of One Kidney and the Relief of the Patient by Nephrectomy..... 318

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Platybasia and Occipital Vertebra Causing Foramen Magnum Encroachment and Resulting Neurologic Symptoms. Lee A. Hadley. New York State J. Med. **44:** 2355–2357, Nov. 1, 1944.

Constriction of the foramen magnum, with neurologic manifestations, may be caused either by platybasia or by so-called occipital vertebra. A case of the latter type is presented.

Occipital vertebra results from incomplete assimilation of the most posterior of the three embryologic cervical segments or scleromeres which form the base of the skull, *i.e.*, the area about the foramen magnum assumes certain features resembling a vertebral segment. (1) There is a hypochordal arch, partially or completely fused to the anterior margin of the foramen magnum, and (2) a partial or complete neural arch outlined about the dorsal surface of the foramen. (3) Transverse processes, more or less fused to the base of the skull may or may not be present. If present, they do not bear a foramen for the vertebral artery. (4) These masses, bearing the condyles, may or may not encroach upon the foramen, distorting its shape. (5) The condyles resemble those of the normal subject. (6) The so-called third condyle, ossiculum terminale, may be present in the anterior portion of the foramen. This is a separate ossification developed from the notochord in the terminal ligament of the odontoid and may embryologically in the normal subject form the tip of that structure. Analogous to the relationship between the atlas and the dens, the third condyle corresponds to the body of the occipital vertebra with the hypochordal arch in front and the neural arch behind.

In the case of occipital vertebra recorded here, roentgenograms showed a normal atlas and a broad, short odontoid process. The posterior margin of the foramen magnum was thinned and below normal level. At operation this was found to bear, somewhat laterally, two cornua—indicating a rudimentary, incomplete neural arch. The outline of the foramen magnum was shaped like a bicycle seat, as the result of two bony masses projecting from the sides of the foramen and encroaching upon its anterior portion. The ossiculum terminale appeared within this narrowed portion as a distinct oval-shaped ossicle entirely separate from the odontoid.

Eosinophilic Granuloma of the Skull. John Raaf. West. J. Surg. **53:** 1–4, January 1945.

A case of eosinophilic granuloma in a six-months-old boy is presented. The lesions, which affected the skull and right fibula, healed rapidly following curettement. After more than a year neither lesion had recurred and no new ones had developed. Preoperative and follow-up roentgenograms of the skull and fibula are reproduced.

Diagnosis of Mandibular Joint Neuralgia and Its Place in General Head Pain. James B. Costen. Ann. Otol., Rhin. & Laryng. **53:** 655–659, December 1944.

Mandibular joint neuralgia embraces some or all of the usual distributions of fifth nerve pain. It belongs in the reflex or secondary group of neuralgias, in which mechanical irritation of branches reflects pain to standard cranial areas.

Any regularly recurring facial pain associated with movement of the lower jaw allows the possible diagnosis of mandibular joint neuralgia, until such condition is definitely ruled out. The author has previously reported a case (Arch. Otolaryng. **36:** 553, 1942) due to fracture or separation of bone of the tympanic plate, proved by roentgen study and by the relief attained from fixing the lower jaw with a strong elastic headband.

The anatomy of the attachment of the mandible to the skull provides obvious chances for impingement of the condyle on sensory nerve branches. Mesially, it may irritate the chorda tympani nerve as it passes out of the glenoid fossa through the petro-tympanic fissure. Posteriorly it may produce impaction of the auricular branches of the auriculotemporal nerve within the temporomandibular articulation, and with wider, loose movement, the condyle may irritate the auriculotemporal nerve itself. When sufficient destruction of joint structures occurs to allow the eroded face of the condyle to rest against the tubercle of the glenoid fossa, an abundant source of reflex pain is produced.

The diagnosis of mandibular joint neuralgia depends upon the history, gross findings, roentgen study, and the test of treatment. There may be a history of some incident producing acute trismus and mandibular joint injury or, again, of some long-standing condition with varying grades of chronic trismus. In the latter event, the early symptoms follow no pattern, and there is no fixed rule as to severity. Although complete loss of the molar teeth invites destruction of the mandibular joints, this does not invariably follow.

The author's concise presentation of the other diagnostic features may well be repeated here.

Gross Findings

- Unilateral or bilateral loss of molar teeth
- Overclosure on malocclusing natural teeth, or ill-fitting dental plates
- Uneven movement of the lower jaw on opening and closing
- Crepitus within the mandibular joints
- Tenderness of the mandibular joints to internal palpation
- Presence of trismus, all grades

Roentgenological Findings

- Density changes in the mandibular joint structures
- Narrowing of spaces between the condyle and glenoid fossa, either uniform or asymmetric
- Widening of joint spaces and wide excursion of the condyles in the open position
- Fixation of one condyle against the tubercle and normal excursion of the opposite condyle
- Erosion of the anterior surface of the condyle and posterior aspect of the articular tubercle
- Change in normal contour of glenoid fossa (deepening) and of the condyle, but with normal bone surfaces (suggestive of abnormal stress)
- Fracture of the tympanic plate
- Impacted unerupted third molar teeth

Test of Treatment

- Observation of pain changes after fixation of the lower jaw with elastic headgear

Decrease or increase of pain after slight change in closed position of the condyle and fixation with elastic headgear (using cork disks of accurate thickness or, better, temporary dental appliques)
Removal of abscessed teeth, impacted teeth, and correction of all sources of trismus
Dental reconstruction to correct condylar malpositions.

STEPHEN N. TAGER, M.D.

Fibrosarcoma of the Larynx. John H. Foster. Ann. Otol., Rhin. & Laryng. **53:** 764–769, December 1944.

A 31-year-old man had a subglottic tumor diagnosed by indirect laryngoscopy and shown roentgenographically to extend into the lumen of the trachea. The mass measured 2 cm. in diameter and appeared to arise from a broad base on the anterior portion of the trachea just distal to the larynx. It was sharply circumscribed, having a somewhat irregular summit, containing no calcifications. The lumen of the trachea was considerably narrowed. The lungs showed normal aeration, with no evidence of infiltration or consolidation. Other chest findings were normal. Bits of tissue, from the size of a pea to that of an almond, had been coughed up on several occasions, and microscopic examination of one of these showed fibrosarcoma.

The tumor was exposed by direct laryngoscopy and found to be attached to the anterior wall in the region of the cricoid isthmus. The greater part was removed with a snare. The patient suffered very little reaction, and relief of dyspnea was complete. Three days later the application of a radium pack to the neck over the site of the tumor was begun, 50 mg. of radium being applied for fourteen hours on three successive nights. Healing was uneventful, and at the time of the report, six months later, there was no sign of recurrence.

STEPHEN N. TAGER, M.D.

THE CHEST

Wounds of the Chest in Pacific Jungle Warfare: Review of Thirty-Two Cases. Harry G. Hardt, Jr: Arch. Surg. **49:** 367–372, December 1944.

The course and results of penetrating chest wounds are influenced by three factors: (1) the character and course of the penetrating missile; (2) the physical condition of the soldier when wounded; (3) the promptness of first aid and transportation to facilities for adequate care. In the series of 32 cases recorded here, the patients were all in the same general physical condition and all had early and efficient treatment by the same medical organization. The character of the missile was the only variable factor. The weapons used and, therefore, the wounds inflicted are considered typical of Pacific jungle warfare.

The most commonly seen wound was caused by fragments of Japanese 50-mm. mortar shells. Such wounds were present in 12 of the 32 cases reported. On detonation this shell disintegrates into many small fragments, producing a large irregular wound with numerous small penetrations at the base if the shell bursts in close proximity or multiple small perforations if it bursts at a distance. The roentgenogram resembles that of a shotgun wound with irregular shot of various sizes. The Japanese hand grenade causes similar wounds, except that no strips of metal (fragments of the detonator) are found. Four men were wounded by large-caliber artillery shells; these caused large jagged wounds with extensive surrounding areas of damage. The foreign bodies were large and irregular and usually lodged in the wound. No knife, bayonet, or case shot shrapnel wounds were seen.

The presence of an obliterated pleural cavity, resulting from previous pleural disease, may cause bleeding to take place into the pulmonary parenchyma. This leads to clouding of the pulmonary field roentgenologically, with later clearing as the blood is expectorated.

In 9 cases in this series the wounds were perforating, in 23 penetrating. The wound was in a "safe area" of the chest with a single exception, in which the heart muscle was injured. In only 6 cases was shock severe; routine prophylactic administration of plasma was thought to have contributed to this low incidence. Hemoptysis was observed in 19 patients, dyspnea in 29, hemothorax in 26, pneumothorax in 10, rib fractures in 10, fractures of the scapula in 3, of the spine in 3, and of the sternum and clavicle in 1 each. Complications included a bronchopleural fistula, 3 infected hemothoraces, and 2 cases of secondary pneumonitis. No deaths occurred at the author's hospital, but 2 men with severed spinal cords were transferred and considered to have a bad prognosis. All patients were evacuated by air, with no untoward effects.

Treatment consists of application of sulfanilamide crystals locally, exploration, and débridement. Primary closure was accomplished in 14 men, the wound was packed open in 11, and in 7 the damage was so slight as to require only cleansing and a dressing. In 1 case a secondary operation for continued hemorrhage was needed, and 3 men required drainage of an empyema. Hemothorax was not treated if asymptomatic; in the presence of symptoms aspiration and replacement with air are recommended in cases seen within three days; simple aspiration otherwise. Persistent unexplained fever and dyspnea are considered indications for intervention.

LEWIS G. JACOBS, M.D.

The Chest X-Ray. Dan G. Morse. Dis. of Chest **10:** 515–527, November–December 1944.

A statistical study of 223,182 chest roentgenograms is presented. Most of the material consisted of Selective Service registrants between the ages of eighteen and thirty-five, of whom 47 per cent were colored. The examinations were made with 4 × 5-in. film, stereoscopically, and subjects with suspicious findings were reexamined with 14 × 17-in. film. Many conditions were found, resulting in 1,801 permanent and 495 temporary rejections.

The incidence of disabling diseases of the chest was 1.018 per cent, but that of active tuberculosis only 0.3284 per cent. Most of the cases of tuberculosis were early and treatable, demonstrating the value of mass surveys. Only 12.7 per cent of a group with rejectable chest disease showed significant physical findings, and only 14 out of every 100 cases of active tuberculosis could have been suspected from physical examination alone. Thirty-six examples of true dextrocardia were discovered, an incidence of 0.16 per cent, or 1 in 6,200. One in every 140 examined had a congenital rib anomaly. There were 452 examples of cervical rib, in none of which were symptoms present. Foreign bodies were another interesting finding. Five men had portions of knife blades in the chest; 4 of these were unaware of the presence of the foreign body and the fifth complained only of occasional vague pain. Shotgun

pellets were discovered in 40 cases and a sewing needle in 1. A triangular area of opacity believed to be due to a piece of auto glass was present in another.

HENRY K. TAYLOR, M.D.

Role of the Roentgenogram in Tuberculosis Finding. Arthur Rest. Rocky Mountain M. J. **41:** 906–910, December 1944.

This article reports a study of 39 persons between the ages of eighteen and forty-two who were entirely unaware that they had active pulmonary tuberculosis until it was revealed by x-ray examination incident to Army induction or a mass survey. In only 4 of the 39 cases was contact given as a probable source of infection.

Eight patients had minimal lesions, 14 moderately advanced, and 17 far advanced disease. The sputum was positive in 4 of the minimal and in 10 of the moderately advanced cases. Twenty patients denied any symptoms of active tuberculosis or a persistent respiratory infection prior to examination. Among the others, the most common complaint was a slight, persistent, productive cough, attributed in some cases to smoking.

The author considers this group of 39 cases of active pulmonary tuberculosis to be representative of a small percentage of similar undiagnosed cases which would be readily revealed by routine x-ray examination of the chest.

PERCY J. DELANO, M.D.

Tuberculosis Among Medical School Personnel at the University of Texas from 1941 to 1944. Jesse B. Johnson and W. S. Wallace. Texas State J. Med. **40:** 428–432, December 1944.

The prevalence among medical students, nurses, and other hospital personnel of pulmonary tuberculosis was revealed by incidences as high as 10 per cent reported from the Harvard Medical School in 1924 and 11.5 per cent from the University of Pennsylvania Medical College in 1930. Subsequently, the incidence of tuberculosis in medical students has been shown to average somewhere around 0.5 per cent, as compared to 0.1 per cent in other college students (Tuberculosis Committee, American Student Health Association, Tenth Annual Report. Journal-Lancet **61:** 115, 1941). Significantly enough, in every available report the introduction of routine annual chest roentgenography for the student body increased the number of cases found by 400 per cent or more.

At the University of Texas Medical School routine chest surveys were begun in February 1941. In that year 2.93 per cent of medical students and 4.16 per cent of student nurses were found to have tuberculosis. In 1942 the incidence was 2.13 per cent for medical students and 0.83 per cent for student nurses. In 1943 the incidence was 1.33 for the student body, while no cases among student nurses were discovered. In 1944 the incidence dropped to 1.06 per cent for the student body. Again no cases were discovered in student nurses. One case yearly was found among faculty members, with the exception of 1942, during which year two cases were discovered.

The explosive development of pulmonary tuberculosis within six months in previously x-ray negative students and the relative ease of survey examination have prompted the authors to adopt a program of four yearly chest examinations for students, two yearly chest examinations for nurses, and one yearly examination for all other Medical Branch personnel.

ELLWOOD W. GODFREY, M.D.

Tuberculosis in West Virginia Industries. J. T. Duncan and C. Scott McKinley. West Virginia M. J. **40:** 373–378, December 1944.

From the standpoint of the long-term tuberculosis program, industrial surveys constitute an excellent case-finding procedure because of the high incidence of tuberculosis among workers of relatively low economic status. Under the war-production program, great numbers of migrant laborers are working long hours and living under excessively crowded conditions; the number of woman employees between twenty and thirty-five, an age group showing a high incidence of tuberculosis, is increased; and other potentially dangerous factors are operative to enhance the susceptibility to tuberculosis among certain groups and to increase the intensity and duration of contact with the disease. Now is the time, during the lag period before the threatened increase in incidence occurs, to set in motion a case-finding and control program in industry.

Surveys were made in four war-industry plants (two large and two of medium size) with a total labor force of approximately 7,600. Of this number, 86 per cent were examined roentgenographically; 4 × 5-inch photoroentgenograms were used and all positive and doubtful cases (8.5 per cent of the total) were restudied with 14 × 17-in. films. Cases of tuberculosis and other conditions found during the surveys were reported to the medical director of the plant (when there was no director, to the patient's physician) and to the county health department.

The incidence of tuberculosis among those examined was 1.4 per cent and of active cases 0.58 per cent. These figures are lower than those—7.0 per cent and 1.3 per cent—obtained in a survey of the furriers' union in New York City several years ago. More recent surveys of 125,000 workers in eleven states, by the U. S. Public Health Service, have revealed a 1.3 per cent incidence, which agrees better with the figures obtained in this series of examinations

In addition to the number of definite cases of tuberculosis, 1.3 per cent of the total were regarded as "suspects," while 7.6 per cent were found to have definite or suspected abnormalities of the cardiac or aortic silhouette.

Of the total cases of tuberculosis, 67 per cent were minimal, 28 per cent moderately advanced, and 4 per cent far advanced. Of the minimal cases, 40 per cent were regarded as active or questionably active; 34 per cent of the moderately advanced cases were active and, of course, 100 per cent of the far advanced cases. The majority of active cases occurred in the age group twenty-five to forty-four years, which, of course, includes a vast majority of men in industry. The rate of incidence, however, increased with age, being highest among those over forty-five.

The employment and the type of work a tuberculous patient should do can be classified according to activity and degree of pulmonary involvement. No person with an active lesion should be employed, but patients with arrested or quiescent lesions of moderate extent may engage in moderate physical work, and those with healed and stable lesions may be allowed more vigorous activity.

Anyone with a suspicious pulmonary lesion should undergo periodic examination in order that a final diagnosis may be reached. In the arrested case, frequent check-ups are indicated. When the patient first returns to work a monthly check-up should be insisted upon, including temperature, weight, blood count, and

x-ray examination and a sedimentation test if practical. The interval between examinations can be increased as time elapses, but should never exceed a year.

J. E. WHITELEATHER, M.D.

Lower Lung Field Tuberculosis. Samuel S. Romendick, Bernard Friedman, and Herbert F. Schwartz. Dis. of Chest **10:** 481–488, November–December 1944.

The authors studied the roentgenograms of 2,354 consecutive patients with pulmonary tuberculosis discharged from the Robert Koch Hospital (St. Louis) from February 1933 to February 1942. Excluded from this study were upper lobe lesions and primary infections; also cases of bronchiectasis and pleural effusion or pleural thickening unless a parenchymal tuberculous lesion was also present. Sixty-three examples of lower lung field tuberculosis were found, an incidence of 2.7 per cent; 44 cases were in females and 19 in males; 43 patients were white and 20 Negroes. The ages ranged from fifteen to fifty-eight, with 49 patients (91.5 per cent) under forty. Among the Negroes, 90 per cent were under thirty; the oldest Negro was thirty-three years of age. There were 37 instances of right-side and 26 of left-side involvement; 24 patients had moderately advanced and 39 far advanced lesions. In onset, symptoms, duration, pathology, and prognosis, the disease differed in no way from the usual form of pulmonary tuberculosis.

HENRY K. TAYLOR, M.D.

Closure of Tuberculous Cavities. John Loesch. Am. Rev. Tuberc. **50:** 500–519, December 1944.

Anatomical observations and studies on the mechanism of closure of tuberculous cavities have been infrequent. The available evidence has indicated that cavities may heal in different ways, but the relative frequency of each mechanism is unknown. In order to throw more light on this subject, the author reports the detailed study of complete closure of cavities in 5 patients, 4 of whom had been treated with pneumothorax and one with strict bed rest. A sixth example, a cavity which had shrunk markedly under strict bed rest, is included as a transitional case. All patients were closely studied roentgenographically and all had postmortem examination.

In general, factors which influence the closure of cavities are: location, duration, thickness of the cavity wall, size, caliber and number of draining bronchi, and possibly, also, the allergic state of the cavity tissue. The mechanism at work in the cases studied was for the most part one of shrinkage of the cavity with simultaneous contraction, approximation, and final obliteration (1) of the cavity outlet or (2) of the tuberculous bronchus at the point of transition into the normal portion by fibrotic tissue, or (3) at both these points when caseous material was retained in the diseased bronchial portion between them. After closure at these points the cavities shrank further and the content retained in them became inspissated and finally partially calcified.

L. W. PAUL, M.D.

Healed Asymptomatic Miliary Tuberculosis. Karl E. Kassowitz. J. Pediat. **26:** 56–60, January 1945.

The roentgenogram of an 8-year-old boy with a positive tuberculin reaction, normal hemogram and sedimentation rate showed a healed primary tuberculosis. Two years later a routine roentgenogram of the chest of this patient, who in the meantime had been attending school regularly, revealed an evenly distributed, healed, calcified miliary tuberculosis. The general physical condition, hemogram, and sedimentation rate were normal. A guinea-pig, inoculated with stomach washings, showed no evidence of tuberculosis. The patient's health, as well as all clinical tests, continued normal for the next three years. At the end of that time x-ray examination showed identical evidence of miliary tuberculosis.

This report adds to the evidence in the literature that hematogenous dissemination and possibly even lymphogenous or bronchogenic spread of tuberculosis may, in rare instances, be unaccompanied by clinical manifestations.

Aetiology of Erythema Nodosum. C. Bruce Perry. British M. J. **2:** 843–847, Dec. 30, 1944.

In order to throw further light on the etiology of erythema nodosum, the author studied a series of 112 cases (38 in males, 74 in females). Under fifteen years of age there were 36 boys and 31 girls, whereas over this age there were 43 females and only 2 males. Of the 112 patients, 61 gave a strongly positive Mantoux reaction and 51 a negative reaction to 0.01 mg. of tuberculin. In 21 of the 61 patients with a positive reaction the roentgenograms showed enlarged hilar shadows on one side; some of these showed also a shadow of the primary lesion, and others a picture similar to that of epituberculosis. One patient had a typical tuberculous cervical adenitis, and one died later of tuberculous peritonitis. In 4 cases a pleural effusion subsequently developed; in 2 of these the roentgen picture was normal at the time of the eruption. A 2-year-old boy with a positive tuberculin reaction but no roentgen evidence of disease subsequently had miliary tuberculosis and died of tuberculous meningitis. Altogether, of the series of 112 patients, 32 (28 per cent) were considered definitely tuberculous, 28 (25 per cent) were probably tuberculous, and 51 (45 per cent) were definitely not tuberculous. Of the 67 patients under the age of fifteen, 29 (43 per cent) were definitely tuberculous and 8 (17 per cent) probably tuberculous. Therefore, in 72 per cent of the cases of erythema nodosum in children of school age or under, the eruption probably marked the development of primary tuberculosis.

Ten of the 112 patients had had acute rheumatism previously; in 4, the heart was normal at the time of the erythema nodosum. In only 2 was there any evidence of a rheumatic relapse. In both the rheumatism appeared to follow the erythema nodosum and not to occur simultaneously. This supports the theory that while the two diseases both follow a streptococcal infection, they are not necessarily the same. Five patients, including the 2 having a rheumatic relapse, gave negative tuberculin reactions, and 4 of these were sensitive to streptococcal nucleoprotein. Of the remaining 5, 2 were certainly tuberculous, as judged by roentgenograms and Mantoux tests.

A family history of erythema nodosum was elicited in 10 cases. Eleven patients gave a history of an acute pharyngitis preceding the erythema nodosum. Of these, 4 had had previous attacks, and all but 2 had a negative tuberculin reaction.

These findings agree with those of other workers, indicating that erythema nodosum must be regarded as the result of a non-specific reaction to a variety of infectious or toxic agents; that it is not a specific disease and occurs only in patients predisposed to it by their constitutional make-up.

Diagnosis of Bronchiectasis: Clinical and Roentgenological Observations. Mark H. Joress and Samuel A. Robins. Dis. of Chest **10:** 489–508, November–December 1944.

Bronchiectasis is, for the most part, an acquired abnormality of the bronchi. It is found frequently in childhood and young adult life and may follow any of the following conditions: recurrent bronchial infection; chronic lobar and bronchiolar pneumonia; whooping cough complicated by pneumonia; acute or chronic lung abscesses; bronchial obstruction due either to extrinsic or intrinsic lesions, as inflammatory cicatrices, carcinoma, aneurysm, mediastinal or lung tumors; chronic empyema.

Pathologically there are atrophy and destruction of the muscular and elastic tissues of the bronchial wall, leading to dilatation. In long-standing cases there is complete disintegration. In advanced cases the infectious process invades the lung parenchyma, resulting in a bronchopulmonary suppuration. Indirect factors in the development of the disease are pulmonary fibrosis, chronic cough, and lobar atelectasis.

There are four main types: ulcerative, stenotic, fibrotic, and "dry hemorrhagic;" the last is thought to be congenital. Anatomically there are cylindrical, saccular, and occasionally fusiform bronchial dilatations. The mild cases show only slight cough, scanty or moderate sputum with no odor, and no hemorrhage. In advanced cases cough is constant and exhausting and the sputum abundant and foul. Hemorrhages, bronchopneumonia, atelectasis, and empyema may supervene. When atelectasis becomes permanent, the lobe shrinks.

The roentgen findings vary considerably and without the aid of contrast substance the diagnosis is not conclusive. It should be suspected in the presence of prominent bronchial markings, honeycombed radiolucent areas, lobar or lobular atelectasis, areas of mottled density or infiltration, or bronchiectatic cavity with fluid. Bronchography is the diagnostic method of choice. The disease must be differentiated from tuberculosis, a foreign body in the bronchus, bronchial carcinoma, and pulmonary abscess.

The authors analyze a series of 62 cases from military and civilian life and include several illustrative case histories. The condition shows similar characteristics in the two groups. It is believed that the aggregate number of cases of confirmed bronchiectasis in the Armed Forces constitutes a fair proportion of the total number of inductees separated from the service for disability. In a series of 1,753 such separations, 2 per cent were for bronchiectasis.

HENRY K. TAYLOR, M.D.

Spontaneous Pneumothorax: Report of Three Unusual Cases. Alfred Goldman and Harold Roth. Ann. Int. Med. **21:** 1011–1021, December 1944.

The first of the authors' cases, in a man of 51, was a spontaneous pneumothorax in the right chest with cystic disease, presumably congenital, in the right upper lung field, an unusual association in an adult. The removal of 1,000 c.c. of air quickly deflated the pneumothorax, and 15 c.c. of the patient's own blood were injected to produce pleural adhesions and prevent, if possible, a recurrence of the pneumothorax. A rapid clinical cure resulted, and subsequent roentgen study showed complete re-expansion of the lung.

The second case was a left-sided spontaneous pneumothorax with complete atelectasis of the left upper lobe and moderate collapse of the left lower lobe. In the roentgenogram, a small tumor-like mass was seen in the left hilar region; a bronchogram showing the left upper lobe bronchus entering this mass proved it to be the left upper lobe. Removal of 250 c.c. of air from the left chest failed to produce expansion of the lung and, because of the atelectasis, bronchoscopy was performed. A small amount of mucoid secretion was aspirated from the left upper main bronchus and on the following day 400 c.c. of air were removed from the left side of the chest. Three months later complete re-expansion of the lung was demonstrable. Only one previous report of atelectasis following idiopathic spontaneous pneumothorax could be found in the literature.

The final case was that of a 28-year-old engineer who, while shoveling dirt, suddenly experienced a sharp pain in the upper anterior part of the right side of the chest, radiating to the upper abdomen. Roentgen examination demonstrated a hydropneumothorax on the right with a fluid level at the anterior end of the fourth rib. In addition, a marked collapse of the right lung with a pleural adhesion at the apex was observed. The pleural cavity was aspirated several times, hemorrhagic fluid being obtained and subsequently replaced by air. Culture of the fluid was sterile and guinea-pig inoculation was negative. The lung slowly re-expanded within a six-week interval, at the end of which time there was a recurrence. Complete re-expansion eventually occurred without further aspiration.

It is generally believed that spontaneous hemopneumothorax is due to rupture of a valve vesicle situated near the pleural surface. Treatment must be individualized. When a considerable amount of fluid is present, it is usually wise to remove it in order to relieve pressure on the mediastinum, but care must be taken not to reduce the intrapleural pressure too greatly, because of the danger of opening up an incompletely healed fistula and thus causing an increase in bleeding in the pneumothorax.

The authors believe that their case is the first to be recorded in the American literature of a large spontaneous hemopneumothorax followed by a recurrence on the same side. STEPHEN N. TAGER, M.D.

Hydatid Cysts of the Lung. Louis R. Davidson. J. Thoracic Surg. **13:** 471–510, December 1944.

This paper is based on the author's experience with four cases of hydatid cyst of the lung and an exhaustive review of the literature. Although the disease is uncommon in the United States, it is believed that there will be more cases as service men return from countries where it is more prevalent. The incidence is greatest in sheep-raising countries, as Argentina, Uruguay, New Zealand, Australia, Italy, Syria, Greece, and Algiers.

Taenia echinococcus is found usually in the intestines of dogs which have eaten infected sheep. Innumerable ova are discharged by the dog in the feces and reach the human intestine through contaminated fruits, vegetables, and water. In man the egg migrates through the bowel wall and usually reaches the liver. From here it may get through into the lung or elsewhere in the body. The embryo then develops, forming a cyst with two layers in the wall. From the inner germinal layer, brood capsules containing scolices develop, and these if ingested by a dog develop into intestinal worms, completing the cycle.

In the lung the cyst enlarges and is surrounded by an adventitial coat from the lung, with slight atelectasis in the adjacent area. This produces a smooth, round, dense shadow on the roentgenogram. In the complicated cases air gets around the cyst between the wall of the cyst, and the advential coat forming the perivesicular "pneuma." The air may get inside of the cyst also, forming the double dome arch or "Cumbo's sign," and later the walls of the cyst may collapse, producing the "camalote formation." These changes are visible on roentgenograms and are supposed to be diagnostic of hydatid cyst.

Cough which later becomes productive, hemoptysis, and chest pain are inconstant complaints. Physical findings are not diagnostic. Eosinophilia is often but not always present. The complement-fixation reaction is variable. The intradermal skin test of Casoni is the best and most reliable test. Certain diagnosis is made only when hooklets, scolices, or cyst membranes are found in the sputum. The cysts occur more commonly in males and more often in the lower lobes. The treatment is surgical removal of the entire cyst.

The illustrations accompanying the article are poor.

HAROLD O. PETERSON, M.D.

Pneumomediastinum in the Newborn. Robert M. Lowman and Charles S. Culotta. Am. J. Roentgenol. **53:** 7–14, January 1945.

Among the variety of conditions apparently associated with mediastinal emphysema in infants are those producing violent respiratory effects such as obstetrical labor, pertussis, and obstructive tracheobronchitis. The factor of overdistention is important. Macklin (Arch. Int. Med. **64:** 913, 1939; J. Michigan M. Soc., **39:** 756, 963, 1940) has shown on experimental animals that spontaneous pneumomediastinum results from pulmonary alveolar rupture. The air passes along the vascular sheaths to the mediastinum. Such factors as congenital deformities of the respiratory system, local trauma, or a pulmonary infectious process may weaken the walls of the respiratory tract so as to produce a break in their continuity and lead to the appearance of air outside of the normal pathways. From the mediastinum air may rupture into the pleural cavities and produce pneumothorax. It may pass downward into the retroperitoneal region and even along the great vessels to the groins. Sometimes it passes upward into the cervical or axillary areolar spaces.

Mediastinal emphysema occurring during the first few days of life is usually manifested by respiratory and circulatory distress. Respirations are rapid and shallow, and dyspnea and cyanosis may occur. Bulging of the precordium, distention of the neck veins, and a fall in blood pressure are due to blockage of the circulation brought about by compression of the systemic and pulmonary veins.

Though the condition may be suspected clinically, diagnosis is essentially a roentgen procedure. In the frontal view of the infant's chest, air outlining the lateral margins of the superior mediastinum may occasionally be seen. In the lateral view, marked bulging of the precordium with a large area of encapsulated air immediately posterior to the shadow of the sternum is characteristic.

The treatment of the authors' 3 cases has been conservative, oxygen and stimulants being administered as was found necessary. It is of significance that all 3 patients had received some form of artificial respiration and attempted insufflation of the lungs. It is difficult to determine whether the attempted resuscitation produced the air in the mediastinum, but it is known that such methods are hazardous and should be administered only by well trained persons.

CLARENCE E. WEAVER, M.D.

Spontaneous Mediastinal Emphysema. Henry Miller. Ann. Int. Med. **21:** 998–1010, December 1944.

The author reviews the literature on spontaneous mediastinal emphysema and adds 4 cases to those previously recorded. Macklin's theory of the genesis of the disease is that areas of atelectasis, by causing overdistention of the surrounding alveoli, may lead to escape of air into the perivascular sheaths. While no atelectatic areas could be demonstrated in the author's four cases, he describes a fifth case, following massive atelectasis, in which this mechanism was undoubtedly active.

The paths of extension of air in the mediastinum tend to follow the fascial planes, particularly the sheaths surrounding blood vessels. The air may spread upward into the root of the neck, the face, axilla, anterior chest wall and arms. It is possible for it to dissect up along the sides of the trachea to the floor of the mouth, extending under the base of the tongue, which becomes elevated. It may extend forward between the parietal pleura and pericardium to appear as blebs overlying the heart, laterally into the opposite lung, and downward into the retroperitoneal space, where it may outline the kidneys, ureters, and renal vessels.

Clinically, the spontaneous type of mediastinal emphysema is characterized by the sudden development of pain in the chest in the absence of antecedent trauma or unusual effort. The pain varies in location and severity, depending largely on the degree of distention of the mediastinal tissue. It may radiate to the upper midback, shoulders, neck, and occasionally down the left arm, as it does in angina pectoris. Its character and radiation have at times led to the erroneous diagnosis of coronary occlusion. Dyspnea, cyanosis, and orthopnea may occur but are not characteristic.

The demonstration of air in the subcutaneous tissues of the neck and anterior chest wall by palpation is diagnostic. The area of cardiac dullness is often diminished or completely obliterated, being replaced by a hyperresonant percussion note.

The pathognomonic sign of mediastinal emphysema is the peculiar sound heard over the pericardium on stethoscopy and sometimes even with the unaided ear. It has been variously described as crunching, crackling, popping, clicking, tapping, snapping, crepitant, etc., and is synchronous with the heart beat. This has been termed Hamman's sign and was attributed by him to the action of the heart on air between the anterior parietal pericardium and the chest wall.

Pneumothorax was present in some of the reported cases of mediastinal emphysema and occurred in 2 of the author's cases. It is usually small and detected only in roentgenograms, though in the author's patients it was discovered on physical examination.

For the roentgenographic demonstration of air in the mediastinum, lateral and oblique views should be taken as well as an anteroposterior view. In the anteroposterior film only the outlying pockets of air may be seen. In this projection a sharp line running parallel to the outer wall of the mediastinum may be detected in

the presence of a pneumothorax. In the lateral and oblique views, air may be visible between the heart and the anterior chest wall or in the posterior mediastinum. In rare cases when the air does not extend forward around the heart, Hamman's sign may be absent and the roentgenographic evidence of air in the mediastinum may be decisive. Air may also be detected in the subcutaneous tissues of the neck and in the retroperitoneum.

In the differential diagnosis, coronary occlusion, pericarditis, dissecting aneurysm and pulmonary embolus must be considered. These can usually be differentiated by physical examination, roentgenographic study of the chest, and electrocardiography.

Treatment is symptomatic, and the prognosis, in general, is excellent. Resorption of air from the mediastinum is rapid when the point of entry is closed.

STEPHEN N. TAGER, M.D.

Esophageal Duplications or Mediastinal Cysts of Enteric Origin. Wm. E. Ladd and H. Wm. Scott, Jr. Surgery **16:** 815–835, December 1944.

Esophageal duplications are cystic structures of variable size with thick walls, lined with mucous membrane. They arise in the posterior mediastinum and usually expand into the right or left hemithorax, remaining retropleural in location. The cysts have been encountered along the entire length of the mediastinum but are most common in the middle third.

The duplications usually have a two-layered muscular wall resembling esophagus. The mucosa, however, does not necessarily correspond to that of the eosphagus; it may closely simulate that of the stomach, and some of the cysts show elements of both esophageal and gastric mucosa. A true serosa is absent, although the pleura is occasionally reflected over the larger cysts so as to resemble grossly a serosal coat.

A significant feature from the surgical point of view is the frequency of an intimate attachment to the esophagus, though an occasional case shows no such attachment.

The contents of the cysts usually resemble gastric juice. The size varies; the largest in the authors' series of 5 cases filled two-thirds of the right thoracic cavity in a 22-month-old boy, while the others averaged about 5 cm. in diameter.

Numerous theories have been proposed to explain the occurrence of alimentary duplications in general. Keith attributes duplication to failure of coalescence of embryological vacuoles in the solid stage of the alimentary tube, so that a continuity of lumen is not established, thus leaving a cystic structure contiguous to some portion of the alimentary tract. This explanation the authors believe to be the most rational one.

Like other forms of alimentary duplication, duplications of the esophagus are usually encountered in infancy and early childhood. The youngest of the authors' patients was three weeks of age, while the oldest was twenty-two months. The oldest patient reported in the literature was three and one-half years of age. The sex incidence is equal.

The symptoms are not only those of an expanding mediastinal mass, but in addition there may be the complicating features of peptic ulceration of the cyst wall. Cough, dyspnea, cyanosis, and recurrent or chronic pneumonias are common presenting complaints. Dysphagia and regurgitation of feedings occur with impingement upon the esophageal lumen. Pain may be caused by distention of the walls of the cyst. Hematemesis and hemoptysis may occur separately or even in the same patient.

Physical examination usually discloses definite indications of thoracic disease, with obvious respiratory difficulty and occasionally cyanosis. There may be massive pleural effusion with signs of chronic pneumonitis and pulmonary compression.

Esophageal duplications present roentgen changes characteristic of posterior mediastinal tumors or cysts. Details of the outline may be obscured by secondary changes in the lung and particularly by pleural fluid. Most duplications are roughly spherical in contour and have a uniform homogeneous density due to their fluid content. The heart and mediastinal structures may be displaced.

Lipiodol bronchograms usually show pulmonary compression by the retropleural duplication and aid in differentiating the latter from bronchiogenic cysts and anomalies. Fluoroscopy of the esophagus with a contrast medium showed no fistulous connection between duplication and esophagus in any of the authors' patients. However, the esophagus was frequently displaced or angulated by the adjacent mass. Esophageal duplications occasionally erode the bodies of the thoracic vertebrae or the overlying ribs.

Surgical extirpation of a duplication of the esophagus is best accomplished by marsupialization of the cyst and subsequent destruction of its mucosal lining.

Reports of the authors' five cases are included. Two of the patients died. J. E. WHITELEATHER, M.D.

Chronic Constrictive Pericarditis Due to a Foreign Body (Needle) in the Pericardium. Bernard Straus. Am. Heart J. **28:** 805–809, December 1944.

A 46-year-old man was admitted to the hospital with a diagnosis of "cirrhosis of the liver with possible obstruction." His chief complaints were loss of weight and abdominal enlargement. According to the history, seven years previously, while he was under an anesthetic for the correction of multiple fractures sustained in a fall, his heart had stopped and he had been given an injection in the third right intercostal space. In the course of this procedure the needle had broken off and was not recovered. About two weeks later a pericardial effusion had developed.

On admission the patient did not complain of pain or shortness of breath. There was no cyanosis in the erect or sitting position, but with the patient supine the face and neck assumed a dusky cyanotic hue. The liver was enlarged and ascites was present.

A roentgenogram of the chest showed fragments of the broken needle in the right border of the pericardium. The heart was not enlarged. Fluoroscopic examination revealed feeble cardiac pulsations, with no change in the shape or size of the heart during forced inspiration and expiration.

The history, roentgen findings, electrocardiographic and other laboratory data led to a diagnosis of chronic constrictive pericarditis of traumatic origin, enlargement of the liver and ascites, and a metallic foreign body in the right side of the chest. The operative findings were: evidences of an old inflammatory process in the intercostal muscles; diminished cardiac excursions; a large pericardio-diaphragmatic adhesion, which was severed; thick, indurated and densely adherent pericardium and fused epicardium. The pericardium over the right side of the heart was removed

In the region of the inferior cava, the two fragments of the needle were found embedded in a dense fibrous sheath and were removed. A suppurative pneumonia developed and death ensued.

The author believes the pathogenesis in this case is related to two factors: (1) the development of an acute inflammatory process beginning at the site of the needle and (2) fibrosis due to chronic irritation of the pericardium because of the needle itself. The first is substantiated by evidence of an old infection of the intercostal muscles along the course of the needle and by the development of a pericardial effusion shortly after the injury. The latter idea is supported by the fact that the thickening, fibrosis, and induration of the pericardium were maximal at the site of the needle.

HENRY K. TAYLOR, M.D.

Echinococcus Cyst of the Heart: Report of a Case. J. Zizmor and M. M. Szucs. Am. J. Roentgenol. **53:** 15-19, January 1945.

Echinococcus cyst of the heart is rare, only 4 cases having been reported previously in the American medical literature, 3 at autopsy and 1 in a living patient; 159 cases were found in the foreign literature. Left-sided cysts appear to be more common than right.

Echinococcus infestation usually occurs in childhood, but the cyst may remain latent for many years. The roentgenologic observation of a rounded mass surrounded by a ring of calcification is of the greatest diagnostic importance. The electrocardiographic findings are non-specific. Eosinophilia is present in 50 per cent of cases with active hydatid disease, while immunologic tests with echinococcus antigen are positive in 87 per cent of active cases. These tests, however, are group specific rather than species specific, and other types of cestode infestation must be ruled out by stool examinations. Immunologic tests may be negative if the echinococcus cyst has been cured or if its contents have become caseous and inert.

This lesion must be differentiated from such cardiac and pulmonary conditions as gumma, aneurysm of the heart, rhabdomyoma, dermoid cyst, simple pericardial cyst, congenital lung cyst, and tuberculous abscess of the lungs or heart with calcification. In all these conditions the echinococcus serologic tests are negative and the characteristic ring-like calcification is not demonstrable roentgenographically

A case is presented of echinococcus cyst of the wall of the left ventricle of the heart in a man of twenty-eight, always resident in the United States. It was symptomless and was discovered on routine chest examination at a maritime training station. There was electrocardiographic evidence of myocardial involvement; the intradermal test with echinococcus antigen was positive, and other types of cestode infestation were excluded. CLARENCE E. WEAVER, M.D.

THE DIGESTIVE SYSTEM

Diagnosis of Disorders of the Small and Large Intestine. Everett D. Kiefer. New York State J. Med. **44:** 2342-2349, Nov. 1, 1944.

This paper was delivered before a general medical meeting and presents for the general practitioner the symptoms and roentgen signs of disorders of the small and large intestine. Thirteen cases are reported to illustrate the important points in the roentgenologic diagnosis of a few of the more common disorders of the intestine. Roentgenograms are reproduced in 9 cases.

Deficiency Bowel Pattern in Polish Refugees, African and Indian Adults and Children (Kwashiorkor). J. Scott Brown and H. C. Trowell. Lancet **2:** 812-816, Dec. 23, 1944.

Working in Uganda (Central Africa), the authors have found numerous cases of malnutrition exhibiting a characteristic clinical picture—a dermatosis consisting of scaly, shiny, dark brown areas; mental depression and sluggishness, and a variety of gastro-intestinal symptoms. The present report is based on a series of 16 such patients examined radiologically and found to show the "deficiency pattern" described by Golden (Radiology **36:** 262, 1941). This group included 2 Polish refugees, 1 Englishwoman, 1 Indian, 10 immigrant African laborers, and 2 African children suffering from the nutritional disorder known locally as kwashiorkor. In all these cases there was a history of inadequate diet over a long period, deficient in total calories, animal protein, fat, green vegetables, and many vitamins.

Roentgen examination in these cases was handicapped by lack of films, and reliance was placed chiefly on fluoroscopy, which usually limited the diagnostic criteria to evidence of gross segmentation. Films were taken only for illustrative purposes, in a selected series, to observe the effect of treatment. In addition to segmentation, examinations often showed, in the small intestine, smoothing of the plicae in the jejunum and coarse flecking, but these features could be distinguished with certainty only on films. In the preliminary fluoroscopy, great gas-distention of the colon was common. Some large atonic stomachs were seen, and in general these "became brisker in their movements after treatment." The appearance of the small intestine conformed to Golden's description; segmentation was usually seen in the middle part. In 2 cases there was great distention of the duodenum with no demonstrable obstruction. As a rule, the colon was wide and poorly haustrated and tended to show segmentation also. Nevertheless, in such cases the colon emptied well. It seemed as if the normal colonic mechanisms were functioning badly and were being assisted or replaced by an alternative mechanism. Outlining of the gas-distended colon by an even layer of barium, 0.5 cm. thick, was often seen. In no case was there any enlargement of the heart as in beriberi. The soft tissues in many cases were remarkably radiolucent, even where no gas-distended intestine intervened. The authors believe this probably indicates a deficiency of minerals in these tissues. Roentgenograms for 3 cases are reproduced.

The patients did not improve on an adequate diet, and the addition of vitamin concentrates was necessary. Early cases responded well to supplementary cooked liver or brewers' yeast, given daily. In more advanced cases very large doses of crude liver extracts, given parenterally, were required. Most of the cases thus treated eventually showed clinical and roentgen evidences of cure. Patients with very advanced deficiency states, especially with infections, did not respond to any form of treatment and soon died. The condition of a few patients improved up to a certain point and then remained stationary.

The relationship of this deficiency syndrome to pellagra or beriberi is uncertain.

Simulation of Chronic Bacterial Dysentery by Paratyphoid B Infection. Daniel N. Silverman and Alan Leslie. Gastroenterology **4:** 53–59, January 1945.

Four cases with generally similar features, all suspected of being chronic bacillary dysentery, are presented. Only one of these, however, actually was chronic bacillary dysentery (Shiga). The other three were found to be due to *B. paratyphosus B* of identical strain as shown culturally and by cross-agglutination. Though this is presumably the first report of chronic intestinal infection simulating chronic dysentery, caused by *B. paratyphosus B*, the authors have made this observation in 10 cases in a period of as many months. The principal features of both infections are a more or less protracted history of abdominal pain, intermittent diarrhea with or without blood or mucus, malnutrition, which may be severe enough to produce the syndrome of avitaminosis, and hypochromic anemia. The resemblance of these cases has been roentgenographic as well as clinical. The more or less constant finding in cases of chronic bacillary dysentery has been the so-called deficiency pattern in the small intestine, *i.e.*, flocculation of the contrast medium and abnormal segmentation of the bowel. This expression of deficiency has been shown to occur to a high degree in the chronic cases of paratyphoid B infection.

In the cases of dysentery, there is generally skin sensitivity to several strains of the dysentery bacillus, but none to organisms of the *Salmonella* group, whereas in patients with chronic paratyphoid B infection, the converse is true: there is skin sensitivity to several *Salmonella* bacilli, but none to members of the dysentery group. In the syndrome of *B. paratyphosus B*, there is heterologous cross-agglutination, as well as homologous agglutination of the organisms by sera of various patients in the group.

Isolated Sarcoidosis of the Small Intestine Simulating Non-Specific Ileo-Jejunitis. C. J. Watson, L. G. Rigler, O. H. Wangensteen, and J. S. McCartney. Gastroenterology **4:** 30–50, January 1945.

Two cases of sarcoidosis involving the small intestine and mesenteric lymph nodes are presented.

Case 1. An unmarried female, 21 years of age, was admitted to the hospital because of lassitude, weakness, and anorexia of approximately one year's duration, with diarrhea and irregular fever for eight months. The examination was negative except for a rather extensive involvement of the small intestine as shown on the x-ray film. This differed from the usual regional ileitis or ileojejunitis in being more diffuse and in exhibiting an appearance suggestive of an extensive polyposis. Roentgen examination of the chest and of the bones of the hands was negative. The Mantoux test was negative at a dilution of 1:100 (1 mg.). Resection of much of the involved bowel resulted in a remission of five months' duration, after which there was recurrence of mild fever and diarrhea as well as some of the roentgen findings. Following a second operation, at which more of the small bowel was resected, including the entire ileum, the patient had remained in excellent health up to the time of the report, although the presence of slight temperature elevation, a low-grade anemia, and increased sedimentation rate were suggestive of mild activity either in the remaining bowel or in other viscera. The pathological study revealed extensive nodular involvement of the resected loops of small intestine with production of a "cobblestone" or hobnail appearance of the mucosa. This change is demonstrated in the roentgenograms. The mesenteric lymph nodes were enlarged and showed diffuse involvement. Histologically, the lesions were typical of sarcoidosis, *i.e.*, epithelioid-cell tubercles with and without giant cells. Caseation was entirely absent, as shown by silver impregnation of the reticulum in the centers of the tubercles.

Case II. A married woman, 25 years of age, was admitted to the hospital because of diarrhea, "gas" and distention, weakness, nausea and vomiting, and progressive weight loss over a period of two years. Except for distinct clubbing of the fingers and temperature ranging between 99 and 101° F., physical examination showed nothing of significance. The Mantoux test was negative at 1:100 (1 mg.). X-ray examination of the chest and bones, including the hands, was negative. Films of the small bowel revealed findings indicating a regional ileitis with some changes in the jejunum of undetermined type. A few areas suggestive of the polyposis-like picture seen in the first case were also observed here. Resection of the involved ileum and some of the cecum resulted in prompt improvement, which had been maintained up to the time of the report. No evidence of jejunal involvement was found at operation. There was no further fever, and the patient gained twenty-five pounds in weight, but a mild diarrhea persisted. A recent x-ray examination revealed evidences which might explain the residual symptoms. There were both marked hypermotility and stasis in several adherent localized bowel segments.

In each of these cases the clinical picture simulated in many respects that of regional ileitis or Crohn's disease. Certain characteristics, however, often present in the latter condition were lacking, as a mass in the right lower quadrant, signs of local peritonitis or fistula development, and the x-ray manifestation known as Kantor's "string" sign. The roentgen findings show other distinct differences from the ordinary picture of ileojejunitis. The abnormal changes were generalized rather than segmental. The mucous membrane pattern suggested swelling and hypertrophy of the folds rather than denudation. Furthermore, the polyposis-like picture in the small intestine is a most unusual finding and is not seen in regional enteritis. Attention to this group of findings may suggest a diagnosis of sarcoidosis in future cases.

Roentgenograms and photomicrographs are reproduced.

Primary Carcinoma of the Third Portion of the Duodenum. Thomas A. Shallow, Sherman A. Eger, and James B. Carty. Surgery **16:** 939–946, December 1944.

Primary carcinoma of the small intestine is of comparatively unusual occurrence; in the third portion of the duodenum it is extremely rare, only 12 authentic cases having been previously reported.

The authors' patient was a 63-year-old white man complaining of intermittent attacks of epigastric fullness one-half to one hour after meals, relieved by belching. At the onset, a year before admission, these attacks occurred at intervals of four to six weeks. They increased in frequency and severity, and for the two weeks prior to admission, symptoms had been constant, with vomiting of bile-stained material. The vomitus contained particles of food ingested several meals earlier but no blood. The patient had lost 20 pounds in the last six months.

A deep, thick, firm, non-tender mass, 2 inches in diameter, was palpable just above the umbilicus. The blood picture showed a slight anemia with a normal white cell count. Gastric acidity was slightly decreased, with bile present in all specimens. Urinalysis and blood tests were negative. Repeated roentgen studies showed almost complete obstruction at the beginning of the ascending loop of the duodenum.

At operation a tumor was found involving the posterosuperior wall of the third portion of the duodenum beneath the superior mesenteric vessels. The adjacent retroperitoneal tissue was indurated, but there was no evidence of extension of the growth or of metastasis. The entire third portion of the duodenum was mobilized and resected and the free ends of the bowel were closed. An antecolic duodenojejunostomy was performed in a side-to-side manner anastomosing the jejunum, about 10 inches from the ligament of Treitz, to the second portion of the duodenum, just distal to the the ampulla of Vater. The jejunal stump was attached to the ligament of Treitz leaving the proximal jejunum available for a gastro-enterostomy should the duodenojejunostomy stoma prove inadequate. Nine months after operation the patient was symptom-free; he had gained weight, and an x-ray examination showed no abnormality.

The removed segment of duodenum contained a central penetrating ulcer 2 cm. in diameter. The cells showed marked hyperchromatism and a few mitotic figures. They infiltrated the entire submuscularis mucosa, submucosa, and a portion of the muscle layers. The diagnosis was primary ulcerative adenocarcinoma of the duodenum. J. E. WHITELEATHER, M.D.

Carcinoma and Lymphosarcoma of the Colon. A Case of Lymphosarcoma of the Descending Colon. Benjamin T. Tilton. Am. J. Surg. **66:** 300–308, December 1944.

Having encountered a lymphosarcoma arising in the descending colon, the author calls attention to the possibility of this type of new growth and the importance of bearing it in mind, "particularly in suspected carcinoma with atypical manifestations."

Carcinoma of the colon is a disease of later life. In its early development it does not give rise to a definite clinical picture, but any abdominal symptoms, however vague and slight, if they persist in spite of the usual dietetic and medicinal measures, call for a thorough examination. The patient may complain of a feeling of abdominal pressure, especially on the right side, colicky pains, gaseous distention, and loss of appetite. Painful distention on the right side is a particularly important sign, especially in elderly persons, when it cannot be attributed to appendicitis. Anemia in an elderly patient is also significant. Persistent abdominal pain, visible blood in the stools, or changes in the bowel habit, particularly increasing constipation, usually lead the patient to consult a physician. A palpable tumor is likely to be a late symptom and is found more often in carcinoma of the cecum and ascending colon. Dyspeptic symptoms are more characteristic of right-sided carcinoma and are frequently associated with pain or discomfort on the right side suggesting appendicitis or cholecystitis. Anemia, which is of toxic origin and not due to loss of blood, is also suggestive of a right-sided growth, since the right side of the colon has a function chiefly of absorption. Obstruction is the outstanding sign of carcinoma of the left colon and has been estimated to occur six times more frequently than when the lesion is on the right side.

An important roentgen sign of carcinoma is a narrowing of the colon which remains constant at a definite point; this remains visible in spite of manipulation or insufflation with air after the expulsion of the barium enema. A second sign is a persistent irregularity in outline of the colon, especially when accompanied by spasm. Not infrequently an exploratory operation has revealed a carcinoma after negative x-ray studies, and a diagnosis of simple spasm of the colon should not be made on the basis of a single examination. Atropine should be given before the second examination. If the narrowing of the lumen is still present, the stricture is probably organic in nature. Lesions of the rectosigmoid junction are frequently not revealed roentgenologically. For this reason, sigmoidoscopy should also be employed when a growth is suspected in this area.

In contrast to carcinoma, lymphosarcoma of the intestine is found most commonly in patients under forty; it is especially common in childhood, when it has a rapid course. The neoplasm originates in the lymphoid tissue of the intestinal wall. Perforation of the mucosa and serosa is unusual, but there may be adhesions with adjacent structures. Cicatricial narrowing of the intestines does not occur as in carcinoma, but rather a dilatation of the wall, as in aneurysm, due to a loss of function of the muscular layer. Metastasis takes place early, to the mesenteric lymph nodes and omentum. These secondary tumors may reach a large size and overshadow the original growth in the intestinal wall. A chronic peritonitis with fluid is not infrequent.

A diagnosis of lymphosarcoma of the intestine is rarely made before operation or autopsy. General symptoms, such as anemia and loss of strength and weight, may be the first evidences of the condition. In some cases local symptoms, such as abdominal pain, sometimes of a colicky nature, may be the first to appear. Acute obstruction of the intestine is rare and is due to intussusception, adhesions, or plugging of the lumen. A mass is a common finding. Roentgenography is not very helpful in the diagnosis of lymphosarcoma. When the small intestine is involved, there may be some dilatation of the intestinal loops with a tendency to local stasis. In the colon, a barium enema may show a deformity or filling defect.

The treatment of both carcinoma and lymphosarcoma of the colon is discussed. The improved prognosis in carcinoma is stressed, with still greater improvement to be hoped for from earlier diagnosis, more thorough preoperative preparation, improved operative technic, and chemotherapy. The results with irradiation in lymphosarcoma of the colon are not encouraging.

The author's case of lymphosarcoma, in a 73-year-old woman, is reported.

Radiologic Aspect of Gall-Bladder Disease. M. C. Sosman. New England J. Med. **231:** 786–794, Dec. 14, 1944.

This is a lengthy and detailed review of the history, chemistry, technical, and diagnostic features of x-ray examination of the gallbladder.

The proper preparation of the patient for the examination is discussed in great detail, and the possibilities of error are pointed out. Radiography should

be of the best to capture the finest details. Errors in interpretation are considered at length. Newer methods and procedures are discussed.

JOHN B. MCANENY, M.D.

Multiple Diffuse Pancreatic Lithiasis. Roentgen Anatomy of the Pancreas: Case Report. Harold H. Sage. Am. J. Roentgenol. **53:** 28–32, January 1945.

Published cases of pancreatic lithiasis are rather rare. The author's case showed sufficient pancreatic calcification to demonstrate the position and relationships of the pancreas. From the head, which overlies the first and second lumbar vertebrae, the organ extends diagonally upward into the left upper quadrant. The body reaches above the lesser curvature of the stomach; the tail crosses the upper part of the left kidney and extends to the hilus of the spleen. It is also in direct relation with the splenic flexure of the colon.

The case reported was of interest, also, for the demonstration of abnormalities in the small intestinal pattern, namely, segmentation, obliteration of mucosal pattern, exaggeration, irregularity and coarsening of the mucosal folds, and hypertonicity. There were also variations in motility of the small bowel. The patient did not manifest any gross clinical evidence of pancreatic insufficiency, but early insufficiency was indicated by a markedly increased excretion of fat and protein in the stools, with characteristic color and bulk.

The case is reported in detail and reproductions of roentgenograms are furnished showing the relationships of the pancreas and the small bowel pattern changes. CLARENCE E. WEAVER, M.D.

THE SKELETAL SYSTEM

Study of the Relative Importance of the Cortex and Spongiosa in the Production of the Roentgenogram of the Normal Vertebral Body. George W. Wagoner, Andrew D. Hunt, Jr., and Eugene P. Pendergrass. Am. J. Roentgenol. **53:** 40–48, January 1945.

Three adult human lumbar vertebrae were obtained at necropsy and prepared as follows: From one the cortex was removed, from another the soft tissues alone were stripped, and in the third the soft tissues and the spongiosa were removed, leaving only a cortical shell. The vertebrae were then immersed in a water phantom and were examined roentgenographically under conditions designed to duplicate those obtaining in the human subject. From this experiment the conclusion was drawn that the "shadow value" of the spongiosa is greater than that of the cortex in producing the characteristic roentgenogram of the vertebral body.

In order to determine the cause of the transverse horizontal shadow seen in 20 per cent of adult vertebrae in lateral films, some further experiments were conducted. An artificial defect made in the cortex along one lateral wall failed to show any shadow of lessened density in lateral roentgenograms. A defect, 3 mm. in diameter, cut through the center of the spongiosa by a small curette introduced through the posterior foramina in an anteroposterior direction, showed a shadow of lessened density in the lateral roentgenogram. In a further study of the "transverse markings," a normal adult vertebra was cut in seven parallel sections in its sagittal plane. These sections were roentgenographed *in toto* and in various combinations. The central sections alone showed the "transverse marking." It is concluded from this experiment that the "transverse marking" is produced by the peculiar structure of the central area of the body. This corresponds in location and size to the central reservoir of the sinusoidal system shown previously to exist within the central structure of the vertebral body.

A study was also made to determine the minimum size of lesions demonstrable roentgenographically. It was found that very small defects in the spongiosa could be demonstrated, but a cortical defect 10 by 10 mm. failed to show in the roentgenogram.

CLARENCE E. WEAVER, M.D.

A Method for Studying Healing of Bone. Alfred Marshak and R. L. Byron, Jr. J. Bone & Joint Surg. **27:** 95–104, January 1945.

The authors have used radioactive elements as tracer substances to investigate the healing of bone. Radiostrontium is closely related to calcium and was used instead of radiocalcium because of technical reasons. Both radiostrontium and radiophosphorus behave as the non-radioactive strontium and phosphorus. Strontium has been found to be retained where new tissue is being formed and, like calcium, is concentrated in bone.

The radioactive elements were injected intraperitoneally into rats with freshly fractured tibias, and the concentration of radioactivity was determined by a Geiger-Müller counter.

Complete data on counts are presented in table form and the concentration of radioactive elements is accurately followed. JOHN B. MCANENY, M.D.

Early Recognition of Endocrine Disorders in Childhood by Roentgenograms of the Wrist to Determine the "Ossification Index." Donald W. Leonard. Am. J. Roentgenol. **53:** 55–61, January 1945.

Several authors have emphasized the relation between endocrine disturbances and the easily obtainable facts about ossification. It has been demonstrated that subsequent roentgenograms may be relied upon to show the effectiveness of endocrine therapy. As pointed out by Clark (Am. J. Roentgenol. **35:** 752, 1936), it is reasonable to accept roentgenographic changes in the wrist as a good index of the extent of departure from the usual rate of ossification throughout the entire body. One reason for this is that this area contains so many primary centers of ossification.

From a summary of the studies of ossification centers in the wrist by various observers, the author has made a diagram of the wrist showing the latest appearance of ossification in each of these centers in the normal child. The capitate and hamate are numbered 6 and 7, respectively, representing the latest appearance in *months* for these centers. The other centers are given numbers representing their latest normal appearance in *years*. The distal epiphyses of the radius and ulna are included. This gives a total of nine centers (the pisiform is not included). The index for the detection of delayed ossification is constructed by setting down the actual age of the patient followed by the figures for the centers actually present. These are placed in their chronological order and zero is substituted if any center has not yet appeared. A separation is made with hyphens between the figures representing months and those representing years. Thus the normal index for the full complement of centers at the age of

seven years becomes 7-67-2456777. At the age of three the normal would be 3-67-2000000. With figures like these on the patient's record, any deviation from the normal becomes immediately obvious. Since the index figures represent the *latest* normal appearance of the centers, some cases which are normal will be found to have centers whose assigned figures are greater than the actual age. CLARENCE E. WEAVER, M.D.

Fracture Dislocation of the Ankle Occurring in Flying Accidents. Theodore James. Brit. M. J. **2:** 372–373, Sept. 16, 1944.

Fracture dislocations of the ankle in fliers occur most often as a result of a crash landing, where the motor is normally in front of the pilot. Sudden displacement of the rudder bar causes extreme dorsiflexion of the foot. The talus is separated at its mid point, and the posterior half, with the fibula and tibia, is displaced posteriorly.

Treatment is urgent, as there is serious interference with the blood supply to the talus. Either open reduction or partial talectomy is advised. In extreme cases total talectomy and arthrodesis may be required.

Q. B. CORAY, M.D.

Sacral Fractures and Injuries to the Cauda Equina. J. Grant Bonnin. J. Bone & Joint Surg. **27:** 113–127, January 1945.

This is an interesting and stimulating article on fracture of the sacrum. The incidence of sacral fracture in association with fractures of the pelvis varies widely according to different authorities. In the author's series of 44 pelvic fractures, there was roentgen evidence of involvement of the sacrum in 20 or 45 per cent.

The weakest portion of the sacrum is through the first and second foramina, and this is usually where the fracture line is to be found. The fracture may occur from rotation where the lower extremity is hyperextended; from leverage where the pelvis is "run over" and its two halves separated; and from shear, where one-half of the pelvis is driven backwards by impact against the knee.

The anatomy of the pelvic bones must be well understood and a good view of the sacrum should be obtained for diagnosis. The obstetric view of the inlet is often of great advantage. Inequalities of the two sides of the sacrum must be considered. At times the fracture is not evident until several weeks have elapsed.

Neurologically, the first and second sacral nerves are affected, producing a combination of motor changes which is readily recognizable. There are weakness of plantar flexion at the ankle, loss of ankle jerk, and loss of power of the hamstrings and glutei. Marked paralysis of the biceps femori was observed in all the author's cases. The calf muscles and hamstrings are tender to the touch. There may be alteration in sensation, paresthesia and referred pain on the outer side of the calf and foot. Bladder and bowel changes are due not to nerve injury but to trauma. Vasomotor and trophic changes are not found.

Treatment of sacral fracture is that of the rest of the pelvis. The pelvis is usually consolidated in about eight weeks and walking is then encouraged. In lesser injuries complete recovery should be attained in a year, but with severe injuries there may be permanent impairment of gait and limitation of activity.

Case reports are presented and drawings and roentgenograms of various types of fracture are reproduced.

JOHN B. MCANENY, M.D.

Congenital Stricture of the Spinal Canal. Münir Ahmed Sarpyener. J. Bone & Joint Surg. **27:** 70–79, January 1945.

The author has made extensive studies of patients with uncontrolled enuresis, spastic deformities of the lower extremities, and clubfoot. In many of these a stricture of the lumbar spinal canal can be demonstrated by suboccipital injection of lipiodol. Release of the constricting bone and soft tissue produces striking results, with almost immediate postoperative relief of enuresis and definite improvement in the spastic states of the lower extremities.

Many good reproductions accompany the article. It comes from Istanbul, Turkey.

JOHN B. MCANENY, M.D.

Osteochondritis Dissecans of the Supratrochlear Septum. H. S. Morton and W. E. Crysler. J. Bone & Joint Surg. **27:** 12–24, January 1945.

The supratrochlear septum is a thin lamina of bone separating the olecranon fossa from the coronoid fossa at the distal end of the humerus. The anterior surface of the septum is entirely within the elbow joint space and covered with synovial membrane. The posterior surface is only partially covered with synovial membrane. As a result of repeated trauma, the anterior surface is at times the site of an osteochondritic process, just as in other joints, and an aseptic sequestrum forms.

The authors describe 6 cases of osteochondritis dissecans of the supratrochlear septum and reproduce roentgenograms of the condition. They believe that these are the first cases to be recorded.

JOHN B. MCANENY, M.D.

Multiple Myeloma in a Fifteen-Year-Old Boy. Michael A. Rubinstein. New York State J. Med. **44:** 2491–2494, Nov. 15, 1944.

A case of plasma-cell multiple myeloma in a boy of fifteen is reported. The patient gave a history of bone pains for three years and of pathologic fracture of the femur. The original diagnosis, on the basis of clinical x-ray studies, was osteosarcoma. Hand-Schüller-Christian disease was also considered. Examination of aspirated sternal marrow, however, showed plasma myeloma cells, and the diagnosis of myeloma was advanced, though at that time no substantiating evidence was found in either the blood or urine. Subsequently, Bence-Jones protein appeared in the urine, at first intermittently and in small amounts, later more often and in increasing quantity. Biopsy of a skull lesion, localized roentgenographically, confirmed the diagnosis. Finally, the blood proteins, at first showing a low normal level with an especially low globulin content, started to rise, attaining 9.1 per cent as compared to 5.2 per cent at the time of the first bone marrow aspiration, about a year previously.

This case emphasizes the importance of bone-marrow aspiration in the diagnosis of myeloma.

GYNECOLOGY AND OBSTETRICS

Role of Roentgen Pelvimetry in the Management of Pelvic Contraction. E. L. King. New Orleans M. & S. J. **97:** 302–306, January 1945.

The author takes a "middle of the road" attitude, believing that roentgen pelvimetry is unnecessary in certain cases and of definite aid in others. It is not es-

sential in the multipara with a history of normal delivery of normal-sized children or in the primipara with a clinically adequate pelvis having ischial spines that are not prominent and are well spaced and with the head engaged before labor starts.

Roentgen information, on the other hand, is desirable in (*a*) the multipara with a history of previous dystocia; (*b*) the multipara who has previously delivered a small child and now presents herself with a much larger child; (*c*) the primipara with an abnormal pelvis or with an oversized child; and (*d*) in breech presentations.

The Ball technic, which gives the volume capacity of the pelvis at various planes and the volume of the fetal head, and the Johnson method of calculating the various diameters are employed. Although it is generally agreed that molding of the fetal head will compensate for a discrepancy of 200 c.c. between the volume of the head and that of the pelvis at any level, the author prefers cesarean section if the pelvic volume is exceeded by 180 or 190 c.c.

The greatest assistance from the roentgenogram is obtained in the study of the plane of least pelvic dimensions. This is demonstrated by a listing of the measurements in 7 cases in which the mid-plane (interspinous or bi-ischial) transverse diameter was less than that of the outlet.

LESTER M. J. FREEDMAN, M.D.

The Outlet Contraction with Especial Emphasis on the Typical Funnel Pelvis. Ralph E. Campbell. Illinois M. J. **86:** 302–310, December 1944.

Funnel pelvis is generally recognized as a contraction in which the transverse diameter of the outlet measures 8 cm. or less, or in which the distance between the lower margin of the symphysis and the tip of the sacrum falls below 9 cm. Three groups are distinguished: (1) typical, in which the superior strait is normal while the inferior strait is contracted; (2) generally contracted, in which the entire pelvis is smaller than normal, while the inferior strait is narrowed to a greater extent than is usual in typical justo-minor pelves; (3) complicated, including a small number of flat or rachitic pelves and cases of osteomalacia, spondylolisthesis, and lumbosacral kyphosis, in which the outlet contraction is superadded to the typical deformity. The commonest etiologic factor in the typical funnel pelvis is lumbosacral assimilation.

Two cases in which x-ray pelvimetry was a valuable adjunct to ordinary pelvimetry are presented. The first patient had a typical funnel pelvis with a narrow intertuberous diameter. The posterior plane of the pelvic outlet was sufficiently compensated, however, by a long posterior sagittal diameter to permit successful spontaneous delivery. In the second case there was an outlet contraction uncompensated in the posterior sagittal diameter. Cesarean section was elected.

ELLWOOD W. GODFREY, M.D.

THE GENITO-URINARY TRACT

Diagnosis of Hydronephrosis Caused by Accessory Renal Vessels. Earl C. Lowry, Joseph C. Hayward, and Donald E. Beard. J. Urol. **52:** 492–496, December 1944.

The authors discuss the symptomatology and diagnosis of hydronephrosis caused by lower pole accessory renal vessels and report a case of hydronephrosis of 5,000 c.c. capacity.

Three separate and distinct types of pyelograms are obtained, depending upon whether the obstructing vessel crosses the renal pelvis, the uretero-pelvic junction, or the ureter. When the obstruction is at the uretero-pelvic junction and the ureteral catheter has passed the obstructing vessel, the pyelogram shows a symmetrically enlarged renal pelvis with a smooth, even contour along its inferior border; the opaque medium is absent at the junction and the ureter is not seen to enter the pelvis.

When the accessory vessel crosses the renal pelvis, it leaves a portion of the pelvis distal to the obstruction which, on the pyelogram, appears crescent-shaped, and the hydronephrotic sac is less distinctly filled. In this type of obstruction, the ureter is well filled and is seen to connect with the renal pelvis.

In obstructions below the uretero-pelvic junction, the ureter and pelvis are dilated above the obstruction and the ureter distal to this point is poorly filled with dye, if at all.

A case is reported of a 31-year-old enlisted man who had a left hydronephrosis due to obstructing aberrant vessels which crossed the renal pelvis proximal to the uretero-pelvic junction. After nephrectomy, the patient returned to full military duty.

N. P. SALNER, M.D.

The Renal and Ureteral Changes Induced by Dilating the Ureter. An Experimental Study. Laurence F. Greene. J. Urol. **52:** 505–521, December 1944.

An experimental study on dogs was undertaken to determine the effects of ureteral dilatation on the ureter and kidney. This is of interest because ureteral dilatation is practised clinically and because adynamic hydronephrosis—*i.e.*, hydronephrosis without mechanical obstruction to the outflow of urine—has recently received much attention.

In the normal dog excretory urograms are unsatisfactory since insufficient medium rests in the tract. Moderate dilatation of the dog ureter (9 to 11 F) results in a decrease in the rate and amplitude of ureteral contraction, a decrease in the rate of transmission of urine down the ureter, and improved unilateral visualization of the urinary tract by excretory urography. Wide dilatation (14 to 16 F) results in ureteral hypertonicity, which acts as a functional obstruction and produces acute pyelectasis and ureterectasis. Repeated wide dilatation of the ureter produces permanent hydronephrosis and hydroureter.

The histologic changes in the ureter resulting from dilatation are loss of mucosa, edema of the submucosa, stretching and rupture of the smooth muscle, and widespread hemorrhage.

The author draws some conclusions of clinical interest.

EDWIN L. LAME, M.D.

Diverticulum of the Female Urethra. Leon Herman and Lloyd B. Greene. J. Urol. **52:** 599–610, December 1944.

The authors define urethral diverticulum as a sac communicating with the urethra and lined by a continuation of the urethral mucosa. Other cavities similarly disposed but lacking a mucosal lining are designated pseudodiverticula. Most authors believe that both diverticula and pseudodiverticula of the urethra

are acquired and usually occur in the absence of urethral obstruction. Trauma incident to childbirth is a frequently ascribed cause. The condition is relatively more common among Negresses, probably owing to the greater frequency and neglect of urethral infections and poor obstetrical care. Calculi occur in 17 per cent of the cases, the majority developing *in situ* from urinary crystals.

There may be no symptoms. In most cases there is mild vesical irritation; rarely obstructive symptoms occur. The inflamed sac is painful, and spontaneous urethral hemorrhages may originate from ulceration or a complicating neoplasm.

The majority of diverticula are about the size of an English walnut and attached to the floor of the middle third of the urethra, so that the patient may observe a painless lump in the vagina. Acute inflammation may lead to closure of the orifice and preclude instrumental studies. Roentgenography, urethroscopy, and urethrography are employed diagnostically and to determine the size and location of the orifice or orifices, the size, location, and form of the sac, whether unilocular or multilocular, and whether smooth-walled or with filling defects suggestive of neoplasm. X-ray visualization of a soft shadowgraph catheter or opaque medium introduced into the cavity is a useful diagnostic measure, but less valuable than cysto-urethrography. In performing the latter the bladder is filled with 10 per cent skiodan and a 20 per cent solution is then injected into the urethral meatus. Urethrograms made after filling the bladder and during voiding have not proved satisfactory. Routine anterior posterior views are taken and occasionally oblique views to demonstrate multiloculation, encircling of the urethra, and extension beneath the trigone. If the cavity is filled with blood clots and exudate, or if the orifice is occluded, it will not be visualized.

The treatment is essentially surgical and consists of removal through the vagina. If contracted, the external meatus and urethra must be enlarged by incision and dilatation.

Six illustrative cases are presented.

CHARLES R. PERRYMAN, M.D.

THE BLOOD VESSELS

Arteriography of Peripheral Vessels. Technical Details. J. R. Learmonth. Lancet **2:** 745–746, Dec. 9, 1944.

Arteriography is used to demonstrate the anatomical arrangement of the peripheral artery tree; the presence of local irregularities in caliber, in arteriosclerosis or Buerger's disease; thrombotic blockage of main trunks in obliterative vascular disease; the extent of collateral circulation; the site and extent of arterial aneurysms; and the site of arteriovenous fistulae. This paper calls attention to the use of this procedure for the last three purposes.

Arteriography should not be a routine procedure in investigation of the complications of arterial wounds. Clinical examination often gives the information required, and final details usually are to be obtained only by careful dissection. Arteriography may be useful, however, in determining the surgical approach in lesions involving the profunda femoris, the popliteal artery, and the beginning of the anterior and posterior tibial arteries, the opaque medium being introduced into the common or superficial femoral artery according to the clinical indications.

The author recommends a spinal anesthetic to remove all vasoconstrictor influences. When the lesion involves the femoral or profunda artery, the patient lies with his leg straight and rotated slightly laterally. When the popliteal is involved, the thigh is slightly flexed, abducted and everted, and the knee bent 20°, its lateral aspect being supported on the table by a sand-pillow. The apparatus used has been a mobile ward set (Watson), 90 kv., 30 ma., fitted with a Machlett grid tube; focus-film distance 30 inches; 12 × 10-in. film, double intensifying screens without grid. With 60 kv. and 50 ma. for femoral and 55 kv. and 50 ma. for popliteal arteriograms, the exposure is 0.3–0.4 second, according to the thickness of the limb. For the injection, an incision is made in the line of the vessel, either in Scarpa's triangle (for femoral-profunda) or in Hunter's canal (for popliteal) without raising the artery from its sheath. Diodone (perabrodil) 50 per cent is used, warmed to body temperature, and a 10-c.c. syringe with an eccentric nozzle and a No. 19 needle. The needle is passed into the artery, bevel downwards and parallel to its wall, to prevent leakage of blood during its passage and provide a long valvular tunnel which will be rapidly closed by intra-arterial pressure when the needle is withdrawn. When blood appears in, or is aspirated into, the syringe, the injection is rapidly completed (less than five seconds). The exposure is made when the injection is almost complete. The needle is then withdrawn, and a moist gauze swab pressed on the vessel at the site of puncture. Pressure is maintained until the film has been developed. If the film gives the required information, the wound is closed. If the lesion has not been demonstrated, a film may be placed more distally and the procedure repeated. Complications are rare. If there is no contraindication, the patient may be out of bed in forty-eight hours.

An editorial on "Limb Arteriography" appearing in the same issue of *Lancet* (page 757) carries an extensive bibliography.

FOREIGN BODIES

Localisation of Foreign Bodies. James F. Brailsford. Lancet **2:** 749–751, Dec. 9, 1944.

Brailsford deplores the attempted surgical removal of foreign bodies after merely preliminary and often misleading roentgenography. Roentgen examination for the detection of foreign bodies is advisable for every wounded part, whatever its nature and appearance. A metal indicator, preferably a straightened safety-pin, is fixed to the skin so that its point indicates the wound. True anteroposterior and lateral views of the part are taken with the beam centered over the point of the pin. Suitably exposed films should be "flat" enough to show the outlines of the soft tissues as well as structures of the bones. In some cases, especially in wounds involving the skull and chest, it is advisable to have an additional roentgenogram, with the central ray directed at a tangent to the bony surface nearest to the foreign body. Fluoroscopy should not be a routine procedure, but is useful as a rough guide to the positions of those foreign bodies whose removal is deemed advisable. Localization of foreign bodies should be so accurate that the time taken by the surgeon in removing them, and the operative damage to the patient's tissues, are reduced to the minimum. Quick methods of localization are likely to be misleading, particularly when the

essential need for operating in the localizing position is overlooked. Moreover, they give little help in estimating the relative positions of the foreign body and anatomical features.

Construction of a Contact Lens for Localization of Intraocular Foreign Bodies. William P. McGuire and Edward C. Raffetto. U. S. Nav. M. Bull. **43:** 1239–1242, December 1944.

The authors describe a practical method for construction of a contact lens for intraocular foreign body localization, using dental materials. An alginate-base powder type of material is used for making the impression of the cornea and immediately surrounding portion of the sclera. This should show a definite corneoscleral junction. The impression, after being fixed, is used to make a stone cast and the actual lens is made on this cast with the use of a clear acrylic resin. The lens is polished and placed on the eye, and four points are marked at the corneoscleral junction in the 12, 3, 6, and 9 o'clock positions. Small holes are drilled through these points and are filled with silver amalgam alloy to make them radiopaque. The eye is anesthetized with 2 per cent butyn sulfate solution and the completed lens is applied. Care should be taken that the four points lie on the corneoscleral junction. Two roentgenograms are made: one anteroposterior, with the forehead and tip of the nose touching the film, and the tube angled 30 degrees toward the feet; the other a true lateral view through the orbits with the affected eye next to the film. For both views, the patient must look straight ahead with the unaffected eye.

For localization on the anteroposterior view, a base line is drawn through both superior orbital margins. The opposing amalgam points of the lens are connected by lines on the film. The intersection of these lines determines the center of the cornea. From this intersection, a line is drawn to the foreign body and projected to the base line. From this, the distance of the foreign body from the center of the cornea and the exact meridian in which the foreign body lies can be determined. On the lateral film, a vertical line connecting the two most widely separated amalgam points is drawn. This gives the plane of the limbus and from this, the location of the foreign body, with respect to the limbus, can be determined.

BERNARD S. KALAYJIAN, M.D.

TECHNIC

Rapid Roentgenography in the Operating Room. W. L. Minear. J. Bone & Joint Surg. **27:** 157–159, January 1945.

The author has constructed a portable developing tank and dark compartment to use in the operating room, in which concentrated commercial liquid developer is used. At 85° F. the developing time is one minute. The regular "hypo" is used. A diagram of the developing compartment is presented.

JOHN B. MCANENY, M.D.

X-Ray Technic for Diagnostic Films with the Weber Dental Machine Model-5. Lester D. Bibler and Douglas W. White. U. S. Nav. M. Bull. **44:** 170–171, January 1945.

The authors describe technical factors for use with the Weber Dental Unit Model-5. They have taken satisfactory films of the pelvis, lumbar vertebrae, ribs, lung, shoulder, and extremities with kilovoltages ranging between 32 and 45; milliamperage from 10 to 13, and time from $^{3}/_{4}$ to 2 seconds. They found, by experimentation, that the exposure factors given in the Weber manual produced overexposed films, and they recommend that, since there are slight variations in each machine, some experimentation be done to obtain the desired results, though the chart included in the article has proved satisfactory in most instances.

BERNARD S. KALAYJIAN, M.D.

RADIOTHERAPY

Supervoltage (One Million Volt) Roentgen Therapy at Walter Reed General Hospital. Milton Friedman. S. Clin. North America **24:** 1424–1432, December 1944.

A million-volt x-ray apparatus was installed at the Walter Reed General Hospital in February 1944. Based upon that hospital's experience, the author concludes that million-volt roentgen therapy is superior to lower voltage radiations in the treatment of malignant lesions.

1. It produces more effective destruction of the neoplasm by virtue of the greater quantity of effective radiation that can be delivered to the tumor with each treatment. As a consequence, the total number of treatments and the duration of the course of treatments are materially reduced.

2. The relatively mild immediate and late skin reactions reduce the discomfort to the patient and permit the administration of larger quantities of radiation through the skin. The increased depth dose to the tumor is attended by an increased incidence of damage to the adjacent normal tissue. This is a calculated risk which is outweighed by the beneficial effects on the tumor.

3. A number of lesions which were formerly considered "radioincurable" may now be considered as "radiocurable."

4. A number of lesions which were efficiently treated with 200 kv. radiation can be more efficiently and effectively treated with 1,000 kv. radiation.

The million-volt machine at Walter Reed Hospital, which, according to the author, is the smallest and most compact in the United States and is as flexible and mobile as any modern 200-kv. machine, is described. Photographs are included.

Treatment of Inoperable Cancer of the Throat (Follow-Up of Previous Report). M. F. Arbuckle, A. C. Stutsman, and Sherwood Moore. Ann. Otol., Rhin. & Laryng. **53:** 689–698, December 1944.

The authors describe a "new fundamental principle" in treatment of carcinoma of the throat worked out by them in an attempt to avoid x-ray injury to the thyroid cartilage and the deadly complications which follow such injury. It consists in removal of the thyroid cartilage prior to the institution of roentgen irradiation. This account follows a preliminary report based on 4 cases published in 1941 (South. M. J. **34:** 219, 1941). At the time of their earlier paper the authors were

unaware of the work of Hautant along similar lines, but credit is given him here (Hautant: Ann. d. mal. de l'oreille, du larynx **46:** 1198, 1927; Flurin and Magdeleine: Ibid. **46:** 1219, 1927).

Eighteen cases are presented in tabular form, with the dates of treatment (except in 4 cases) and the results. The patients were seen in the wards of the county and city hospitals and in the authors' practice. All had typical late generalized cancer of the throat with lymph node involvement, cachexia, and interference with deglutition, respiration, and phonation, accompanied by pain and weight loss. All were without possible hope of cure by surgical means. In some the original site of the lesion was the larynx; in others the epiglottis, and in still others the base of the tongue or laryngopharynx. In one or two the cancer had apparently started in the hypopharynx, and in one woman the lesion involved and blocked the mouth of the esophagus. In nearly all cases the cancer had spread to the neck, involving the lymph nodes and the thyroid gland. In most of the males some constitutional disease was an added difficulty.

In spite of these unfavorable circumstances, the authors are able to report 8 patients living and free of signs of cancer, with normal deglutition and a good voice. One of those still living was treated in 1936. The follow-up period for the others is shorter, being less than a year in some instances. Nearly all the survivors have a normal airway but wear a small tracheotomy tube, which they keep plugged. All cases were proved microscopically and graded according to the degree of cellular differentiation. All types, including well differentiated and poorly differentiated, were present. The type apparently had no influence on the response to irradiation. No attempt at surgical removal of the tumor was made.

Incision for removal of the thyroid cartilage is made in the mid-line from the level of the hyoid bone down to the fourth tracheal ring. A tracheotomy tube is inserted through the third and fourth rings. The outer perichondrium and the thyroid cartilages are divided in the mid-line, with care not to open the inner perichondrium, and complete subperichondrial elevation, outer and inner, is done. The cartilage is then lifted out with forceps and the wound closed in layers. Care is required while splitting the partially calcified thyroid cartilage to avoid injury to the cricoid cartilage.

In the cases reported, roentgen therapy was instituted about ten to thirty days after operation, the Coutard technic being used. In the 7 cases for which details are given, the total dosage ranged from 1,200 to 3,600 r to each side of the neck.

Close co-operation between the surgeon and the radiologist is imperative in order that the dosage be properly controlled. Dosage sufficient to kill cancer cells is invariably accompanied by skin burns and x-ray sickness. Local signs, usually referred to as mucositis and epidermitis, and a constitutional reaction evidenced by vomiting, prostration, dehydration, failure of appetite, rapid weight loss, or exacerbation of serious constitutional disease, are warning signals.

STEPHEN N. TAGER, M.D.

Chemotherapy and X-Ray Radiation in Treatment of Cellulitis of the Head and Neck. Samuel S. Wald. U. S. Nav. M. Bull. **43:** 1200–1204, December 1944.

The author describes the treatment of cellulitis of the head and neck following extraction of lower third molars. He states that the patients may be very ill, with a temperature as high as 105° and diffuse hard indurated swelling of the face and neck including the lymph nodes in the neck. Sulfathiazole and x-ray therapy were used in most of these cases. When sulfa drugs were contraindicated, penicillin was used without x-ray therapy. When sulfathiazole was not tolerated, sulfadiazine was substituted. An attempt was made to maintain high blood levels of the sulfa drug used until the temperature and symptoms subsided, an average of seven to ten days. The x-ray therapy used was 150 r every other day for three treatments (120 kv.p., 25 cm. distance, and 2 mm. aluminum). A few patients were given one additional treatment, but a total of 600 r was not exceeded in any of the 100 treated. In addition to the chemotherapy and irradiation, abundant fluids, hot wet dressings, intra-oral irrigation, and sedatives were employed. Only very occasionally was it necessary to resort to surgical drainage.

The author gives a detailed report of one case in which numerous attempts at surgical drainage were made, with eventual production of a chronic suppurative lesion which did not respond to penicillin therapy but did respond well to sulfa medication plus x-ray therapy.

BERNARD S. KALAYJIAN, M.D.

Exit Dose in Dermatologic Roentgen Therapy. George C. Andrews, Carl B. Braestrup, and Eldred B. Heisel. Arch. Dermat. & Syph. **50:** 355–360, December 1944.

A series of studies was made by the authors to determine the exit dose of low-voltage x-rays for various parts of the body. The dosage was measured by a roentgenometer with a small thimble chamber. All measurements were made at a target-skin distance of 30 cm. with a circular field 24 cm. in diameter. Three different voltages were used: 60 kv. and 100 kv. with no filter, and 135 kv. with 3 mm. Al.

The parts studied were the hands, feet, and face. The hands were placed on a treatment table with the thimble chamber beneath it between the third and fourth metacarpals. Care was taken that the thimble chamber was not placed under the bone. The beam was then directed through the dorsum of the hand. The feet were studied in the same manner, the thimble chamber being placed between the third and fourth metatarsals. Studies at the ala of the nose were made by pressing the thimble ionization chamber between the nose and cheek and giving a side exposure.

Measurements of the exit dose were taken on the hands of 40 patients. It was found that the average exit dose was 17.5 per cent of the air dose at 65 kv., 30.5 per cent at 100 kv., and 60 per cent at 135 kv. with 3 mm. Al. When 75 r in air is given to both sides of a hand, the total skin dose is 94 r at 65 kv., 109 r at 100 kv., and 133 r at 135 kv. with 3 mm. Al.

From these calculations, it can be shown that if 100 r is to be given to both surfaces of the hands, the air dose should be 80 r at 65 kv., 70 r at 100 kv., and only 55 r at 135 kv. with 3 mm. Al.

A chart is included with the article showing the exit dose at the three voltages in relation to the thickness of the hand. At 65 kv. there is a marked drop in exit dose as the thickness of the hand increases; at 100 kv., only a very moderate drop, and at 135 kv. with 3 mm. Al, very little change is seen.

The same findings obtained in studies of the hand were seen in studying dosages of the feet and face. The

authors conclude that the use of 60 kv. (half-value layer, 0.7 mm. Al) has definite advantages over higher-voltage irradiation. JOSEPH T. DANZER, M.D.

Tissue Dose Estimation in Combined Roentgen and Radium Therapy for Carcinoma of the Uterine Cervix. William E. Howes. New York State J. Med. **44:** 1563–1568, July 15, 1944.

The method used at the Brooklyn Cancer Institute for estimating the tissue dose in combined roentgen and radium therapy for carcinoma of the uterine cervix is described. Diagrams showing two specific geometric arrangements of radium sources are used as a basis for determining the radium dosage to certain theoretic fixed points in the pelvis. The dose in gamma roentgens is arrived at in accordance with tables representing roentgens per milligram hour delivered to these points. For the roentgen dosage a depth dose graph is drawn up from actual measurements of each patient.

RADIATION EFFECTS

Post-Irradiation Bone Changes. F. R. Gratzek, E. G. Holmstrom, and Leo G. Rigler. Am. J. Roentgenol. **53:** 62–76, January 1945.

Since November 1940, at the University of Minnesota Hospitals, routine pelvic roentgenograms have been made, before treatment and at yearly intervals thereafter, in all cases referred for deep roentgen therapy of malignant tumors of the pelvis. In addition, all patients treated since 1936 have been recalled and examined roentgenologically for evidences of injury to the pelvic bones. Twenty-five instances of bone necrosis or spontaneous fracture were discovered in 19 patients.

During the period 1936–41, 568 female patients were treated with irradiation for malignant tumors of the internal genitalia. Eighteen had serious bone sequelae, an incidence of 3.2 per cent. In one patient, signs of necrosis appeared almost six years after completion of the radiation therapy. In 541 male patients treated for carcinoma of the bladder or prostate, no fractures or other bone sequelae which could be assigned to the irradiation were encountered. Possible factors in producing the striking difference in sex incidence are the differences in anatomy (the same factors which produce traumatic fractures three times more often in females than in males), the more restricted fields of radiation often used in the treatment of carcinoma of the prostate, and the shorter life span of the latter patients after irradiation.

The quantity of radiation applied is undoubtedly an important factor contributing to the subsequent bone changes. The incidence of bone lesions is said to have increased appreciably after the institution of more intensive therapy. Radium application is thought to play a minor role.

The authors' series included 13 fractures of the femoral neck in 11 patients (2 bilateral); 2 cases of multiple fractures of the pelvis, in one of which a fracture of the femoral neck developed later; 8 cases of definite sclerosis or areas of necrosis in the head or neck of the femur (1 bilateral); 1 case of sclerosis of the right ilium with fracture of the pubic rami.

In no instance did the authors find fractures or necrosis in patients wholly free from symptoms, and in several cases there were well developed symptoms of bone involvement before changes were visible on the roentgenogram. While evidences of necrosis usually appear only after an interval of six to eight months, 2 cases were encountered in which roentgen changes were demonstrable within five months.

Fractures of the femoral neck are preceded by sclerotic changes. Careful study of the trabeculae will reveal areas of increased density in most instances. Especially significant is the appearance of a transverse line of density across the femoral neck; the head of the femur becomes more dense, and areas of rarefaction then appear. A similar course is observed in the acetabulum. These progressive changes resemble those of osteochondritis in the femoral head and of post-traumatic aseptic necrosis and caisson disease and point to an origin in vascular alterations.

In general the prognosis of radiation changes in the bones is fairly good, many excellent recoveries having been observed, with little disability.

The authors have tabulated the principal features in their 19 patients and report 8 of the cases in greater detail, including the 3 with multiple fractures of the pelvis involving the sacrum and pubic rami.

A case of retardation of bone growth resulting from irradiation of the soft tissues of the thigh in infancy is also reported. A review of the literature is given.

CLARENCE E. WEAVER, M.D.

Study by the Newer Renal Function Tests of an Unusual Case of Hypertension Following Irradiation of One Kidney and the Relief of the Patient by Nephrectomy. Archie L. Dean and Jules C. Abels. J. Urol. **52:** 497–501, December 1944.

A 20-year-old female with normal blood pressure and apparently normal kidneys was irradiated in the left upper quadrant for a growing tumor which was thought to be lymphosarcoma or Hodgkin's disease. She received 3,000 r to an anterior and posterior portal with complete disappearance of the mass. Seven years later, headache and hypertension in the neighborhood of 184/125 developed.

Urine concentration tests and phenolphthalein excretion revealed no significant difference between the two kidneys. With more refined methods, however, which measure glomerular filtration, tubular absorption, and rate of blood flow through the kidneys, the left kidney was found to be markedly deficient in all. Mannitol clearance was used to measure glomerular filtration, while sodium para-amino-hippurate clearance was used to determine renal blood flow and tubular damage. Vascular lability was poor.

Following the removal of a sclerosed left kidney, the blood pressure and vascular lability returned to normal, and the function of the remaining kidney may have improved according to the newer renal function tests. DAVID KIRSH, M.D.